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AUGUST 1961

Monthly Report

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data are provided to the Division of Radiological Health by other Federal agencies, State health departments, and foreign governments. Except where material is directly quoted or otherwise credited, summaries and abstracts are prepared by the staff of the Data Collation and Analysis Unit, Division of Radiological Health. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
Atomic Energy Commission
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SECTION I. — AIR

Radiation Surveillance Network

Division of Radiological Health, Public Health Service

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in levels of environmental radioactivity due to fallout from nuclear weapons tests. Although no nuclear tests have been conducted by the United States since 1958, the program has proved sufficiently valuable that it has been extended to a year-round basis. Currently, it consists of 45 stations at urban locations (see figure 1) operated by State and local health department personnel with 2 stations operated by Public Health Service personnel.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone. Field measurements with a portable survey meter enable the operator to estimate the amount of beta activity of particulates in air at the station five hours after collection by comparison with a known source. The filters are then forwarded to the central laboratory of the Radiation Surveillance Network in Washington, D.C., for a more refined measurement using a thin window proportional counter. The stations located at Atlanta, Georgia, and Cincinnati, Ohio, conduct their own laboratory analyses.

Air samplers are in operation at the 45 stations on an average of 70 percent of the week. Air is drawn through a cellulose carbon-loaded dust filter using a high volume air sampler. The radioactive material in fallout adhering to small particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples. About 85 percent of the stations collect samples of precipitation which are sent to Washington, D.C., for analysis. Values are now below limits of detection by present instrumentation.

Tables 1 and 2 summarize the data for March 1961.

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS

TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR-GROSS BETA DETERMINATIONS, MARCH 1961

Station location	Number samples	Maximum ($\mu\mu c/m^3$)	Minimum ($\mu\mu c/m^3$)	Average [1] ($\mu\mu c/m^3$)	Station location	Number samples	Maximum ($\mu\mu c/m^3$)	Minimum ($\mu\mu c/m^3$)	Average [1] ($\mu\mu c/m^3$)
Anchorage, Alaska	23	0.18	<0.10	<0.11	Minneapolis, Minn	9	<0.10	<0.10	<0.10
Fairbanks, Alaska	22	0.15	<0.10	<0.10	Pascagoula, Miss	20	0.29	<0.10	<0.16
Juneau, Alaska	23	0.11	<0.10	<0.10	Jefferson City, Mo	22	0.11	<0.10	<0.10
Phoenix, Ariz	6	0.20	<0.10	<0.17	Helena, Mont	5	<0.10	<0.10	<0.10
Little Rock, Ark	20	0.15	<0.10	<0.11	Trenton, N.J	12	0.22	<0.10	<0.12
Berkeley, Calif	23	0.12	<0.10	<0.10	Santa Fe, N.Mex	21	0.25	<0.10	<0.16
Los Angeles, Calif	21	0.15	<0.10	<0.11	Albany, N.Y	31	0.15	<0.10	<0.10
Denver, Colo	21	0.18	<0.10	<0.12	Gastonia, N.C	20	0.19	<0.10	<0.11
Hartford, Conn	31	0.18	<0.10	<0.10	Oklahoma City, Okla	19	0.15	<0.10	<0.12
District of Columbia	25	0.20	<0.10	<0.11	Ponca City, Okla	27	<0.10	<0.10	<0.10
Jacksonville, Fla	23	0.20	<0.10	<0.11	Portland, Oreg	21	0.12	<0.10	<0.10
Atlanta, Ga	14	<0.10	<0.10	<0.10	Harrisburg, Pa	22	0.18	<0.10	<0.10
Honolulu, Hawaii	20	<0.10	<0.10	<0.10	Providence, R.I	23	0.20	<0.10	<0.11
Boise, Idaho	9	0.19	<0.10	<0.13	Columbia, S.C	10	0.15	<0.10	<0.11
Springfield, Ill	9	<0.10	<0.10	<0.10	Pierre, S.Dak	8	0.23	<0.10	<0.12
Indianapolis, Ind	30	0.13	<0.10	<0.10	Austin, Tex	22	0.21	<0.10	<0.11
Iowa City, Iowa	23	0.13	<0.10	<0.10	El Paso, Tex	20	0.46	0.18	0.28
Topeka, Kans	23	0.14	<0.10	<0.10	Salt Lake City, Utah	30	0.19	<0.10	<0.11
New Orleans, La	4	0.14	<0.10	<0.10	Richmond, Va	23	0.12	<0.10	<0.10
Baltimore, Md	22	0.13	<0.10	<0.10	Seattle, Wash	21	<0.10	<0.10	<0.10
Lawrence, Mass	22	0.12	<0.10	<0.10	Madison, Wis	25	0.11	<0.10	<0.10
Lansing, Mich	30	0.14	<0.10	<0.11	Cheyenne, Wyo	8	0.15	<0.10	<0.11

[1] Weighted average obtained by summing the products of individual sampling times and the corresponding activities, and dividing by the summation of the individual sampling times.

TABLE 2.—RADON AND THORON MEASUREMENTS AT CINCINNATI, OHIO, FEBRUARY 27–MARCH 24, 1961

End of sampling period	Continuous sample collection			Radon[a] a.m. ($\mu\mu c/m^3$)	Radon-[b] thoron p.m. ($\mu\mu c/m^3$)	Thoron[c] ($\mu\mu c/m^3$)	Beta[d] activity ($\mu\mu c/m^3$)
	Sample change time	Sample period (hours)	Volume				
Feb. 27	0810	72.0	86.2	400	120	1.9	0.04
28	0814	24.1	29.0	50	60	0.7	0.05
Mar. 1	0828	24.2	29.6	90	50	0.4	0.01
2	0815	23.8	28.6	120	60	1.3	0.02
3	0800	23.7	28.7	150	80	0.3	0.08
6	0807	72.1	86.0	70	100	0.8	0.06
7	0809	24.0	28.8	140	50	0.8	0.08
8	0809	24.0	29.1	170	120	0.8	0.06
9	0810	24.0	28.3	40	170	0.4	0.01
10	0800	23.8	29.0	50	30	0.3	0.01
13	0814	72.2	86.4	130	40	1.8	0.08
14	0819	23.3	27.9	110	40	0.3	0.00
15	0818	24.0	28.1	110	110	0.8	0.02
16	0807	23.8	28.5	80	60	0.4	0.02
17	0812	24.1	29.1	50	60	0.7	0.00
20	0810	72.0	85.8	120	30	1.1	0.06
21	0816	24.1	28.6	120	60	0.7	0.09
22	0806	23.8	29.0	140	100	1.0	0.06
23	0805	24.0	28.6	110	130	0.3	0.06
24	0822	24.3	28.9	140	90	0.6	0.02
			Average	120	78	0.8	0.04

[a] Radon concentrations are derived from alpha measurements determined immediately after the sampling period (24 to 72 hours) has ceased. Reported radon concentrations have been corrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ± 11 and ± 35 $\mu\mu c/m^3$.

[b] Radon concentrations are derived from alpha measurements made in the afternoon (3 p.m.) approximately 7 hours after the new sampling period has begun. Therefore, the reported values were actually determined one working day prior to the date reported here. Reported radon concentrations are uncorrected for any thoron daughter interferences. Twice the standard deviation (2σ) falls between ± 10 and $\pm 22 \mu\mu c/m^3$.

[c] Thoron concentrations are derived from alpha measurements referred to in footnote (a) but are counted 7 hours after the sampling period has ceased. Reported values are corrected to the time of removal of the filter holder. Twice the standard deviation (2σ) falls between ± 0.2 and $\pm 0.5 \mu\mu c/m^3$.

[d] Gross beta concentrations are based on measurements made at least 4 days after the end of each sampling period (24 to 72 hours). Twice the standard deviation (2σ) falls between $+0.01$ and $\pm 0.04 \mu\mu c/m^3$.

Sampling Programs For Radioactivity In Air

The following article is the first in a series of discussions intended to present summaries of atmospheric levels of radioactivity. This article summarizes surface air fission product gross beta concentration determined by the Radiation Surveillance Network, Public Health Service, at various locations throughout the United States during the period 1957–1960. The presentation and data were compiled by Messrs. Roscoe H. Goeke, John G. Bailey, and Andreas P. Zizos of the Data Collation and Analysis Unit, Division of Radiological Health, Public Health Service.

The authors wish to express their appreciation to the Program Operations Branch, Division of Radiological Health, for supplying the basic data necessary for this presentation, and to the staff of the Atmospheric Radioactivity Research Project, U.S. Weather Bureau, for their review of the text.

Radiation Surveillance Network, Surface Air Fission Product Gross Beta Determinations

Division of Radiological Health, Public Health Service

Introduction

The Public Health Service, by an agreement in April 1956 with the Division of Biology and Medicine, U.S. Atomic Energy Commission, established a nationwide Radiation Surveillance Network with its central laboratory located in Washington, D.C. The Network was originally established to perform surveil-

lance activities during Operation Redwing, conducted May through July 1956 at the Eniwetok Proving Grounds. The Network commenced operation in April and ceased intensive operation in September of that year. Data were received from Hawaii, Alaska and twenty-eight other states.

An extension of the Public Health Service–Atomic Energy Commission agreement in April 1957 provided a resumption of intensive sampling during Operation Plumbbob (May–October 1957) at the Nevada Test Site, (NTS) and since July 1960 the Network has been financially supported by the Public Health Service.

The Network's fission product gross beta surveillance activities were of sufficient value that sampling was extended to a 24-hour year-round basis. Currently, the network consists of 45 permanent urban stations, 43 of which are operated by State, Territorial or local health departments, and 2 by the Public Health Service.

Figure 1 illustrates the geographic location of the collection stations, and table 1 presents their respective coordinates and elevation.

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS

TABLE 1.—COLLECTION SITES, RADIATION SURVEILLANCE NETWORK, 1961

Station location	Latitude	Longitude	Elevation (meters)	Station location	Latitude	Longitude	Elevation (meters)
Albany, N.Y.	42° 42′ N	73° 46′ W	26	Klamath Falls, Oreg.	42° 12′ N	121° 48′ W	1332
Anchorage, Alaska	61 10 N	149 45 W	28	Lansing, Mich.	42 45 N	84 35 W	256
Atlanta, Ga.[1]	33 45 N	84 25 W	345	Las Vegas, Nev.[1,2]	36 11 N	115 09 W	632
Austin, Tex.	30 16 N	97 43 W	198	Lawrence, Mass.	42 41 N	71 11 W	16
Baltimore, Md.	39 18 N	76 38 W	43	Little Rock, Ark.	34 43 N	92 16 W	92
Belle Fourche, S.Dak.[2]	44 39 N	103 40 W	920	Los Angeles, Calif.	35 00 N	118 12 W	101
Berkeley, Calif.	37 52 N	122 18 W	98	Madison, Wis.	43 04 N	89 23 W	265
Boise, Idaho	43 38 N	116 12 W	866	Minneapolis, Minn.	44 57 N	93 15 W	255
Cheyenne, Wyo.	41 09 N	104 48 W	1861	New Orleans, La.	30 00 N	90 05 W	16
Cincinnati, Ohio	39 06 N	84 30 W	191	Oklahoma City, Okla.	35 28 N	97 31 W	378
Columbia, S.C.	34 00 N	81 02 W	90	Pascagoula, Miss.	30 21 N	88 33 W	3
Denver, Colo.	39 45 N	105 00 W	1618	Phoenix, Ariz.	33 27 N	112 04 W	337
El Paso, Tex.	31 46 N	106 28 W	1148	Pierre, S.D.	44 22 N	100 20 W	448
Fairbanks, Alaska	64 44 N	147 39 W	133	Ponca City, Okla.	36 43 N	97 06 W	310
Gastonia, N.C.	35 16 N	81 12 W	247	Portland, Oreg.	45 30 N	122 37 W	48
Harrisburg, Pa.	40 16 N	76 50 W	115	Providence, R.I.	41 50 N	71 25 W	23
Hartford, Conn.	41 45 N	72 40 W	12	Richmond, Va.	37 34 N	77 26 W	29
Helena, Mont.	46 36 N	112 01 W	1252	Salt Lake City, Utah	40 45 N	111 51 W	1324
Honolulu, Hawaii	21 18 N	157 51 W	4	Santa Fe, N.Mex.	35 40 N	106 05 W	2133
Indianapolis, Ind.	39 45 N	86 10 W	233	Seattle, Wash.	47 45 N	122 25 W	36
Iowa City, Iowa	41 39 N	91 32 W	209	Springfield, Ill.	39 47 N	89 38 W	196
Jacksonville, Fla.	30 20 N	81 40 W	13	Topeka, Kans.	39 03 N	95 40 W	304
Jefferson City, Mo.	38 35 N	92 12 W	191	Trenton, N.J.	40 14 N	74 44 W	18
Juneau, Alaska	58 20 N	134 35 W	24	Washington, D.C.	38 55 N	77 00 W	22

[1] Operated by the Public Health Service.
[2] Inactivated.

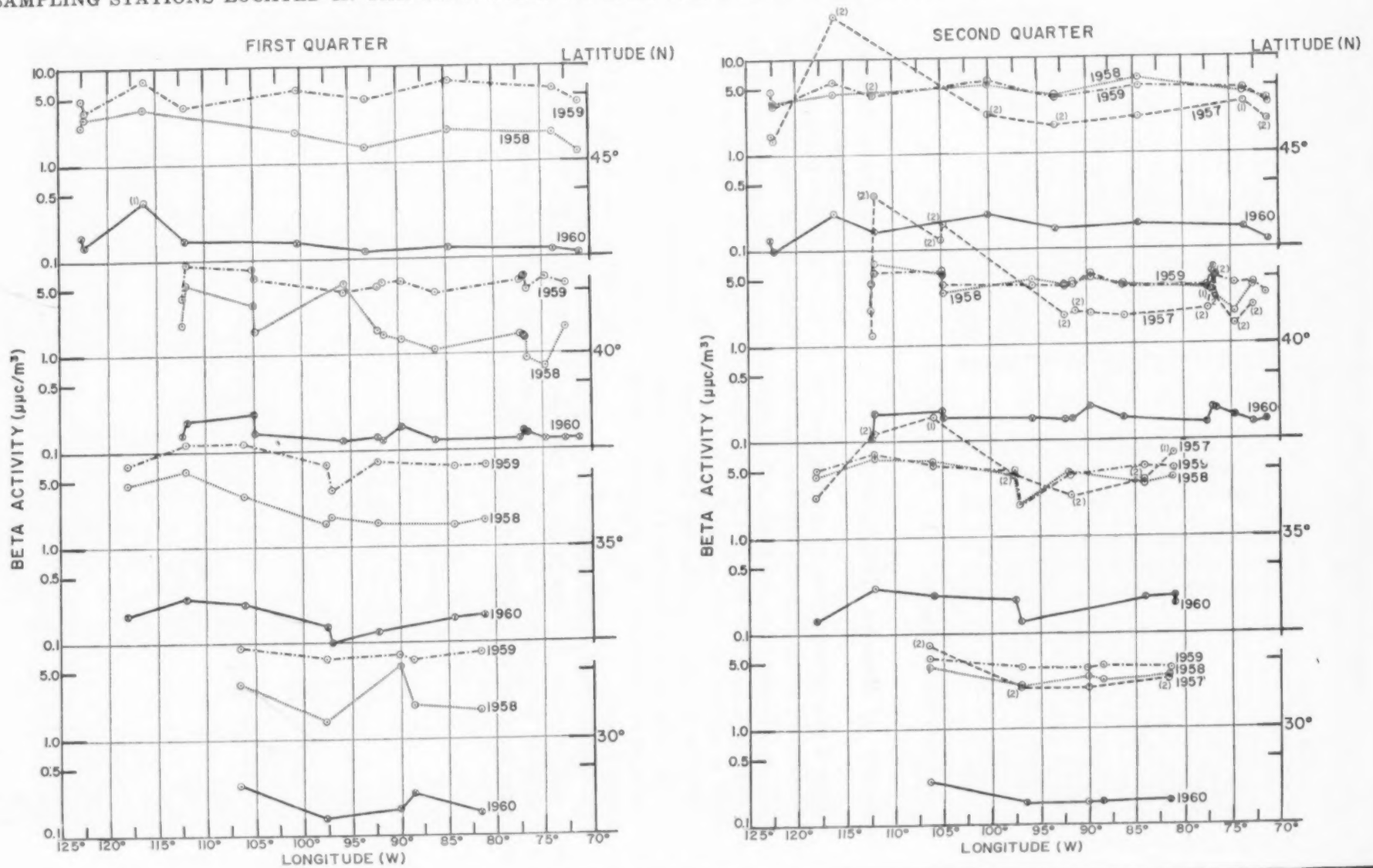
Summary of Results, 1957-1960

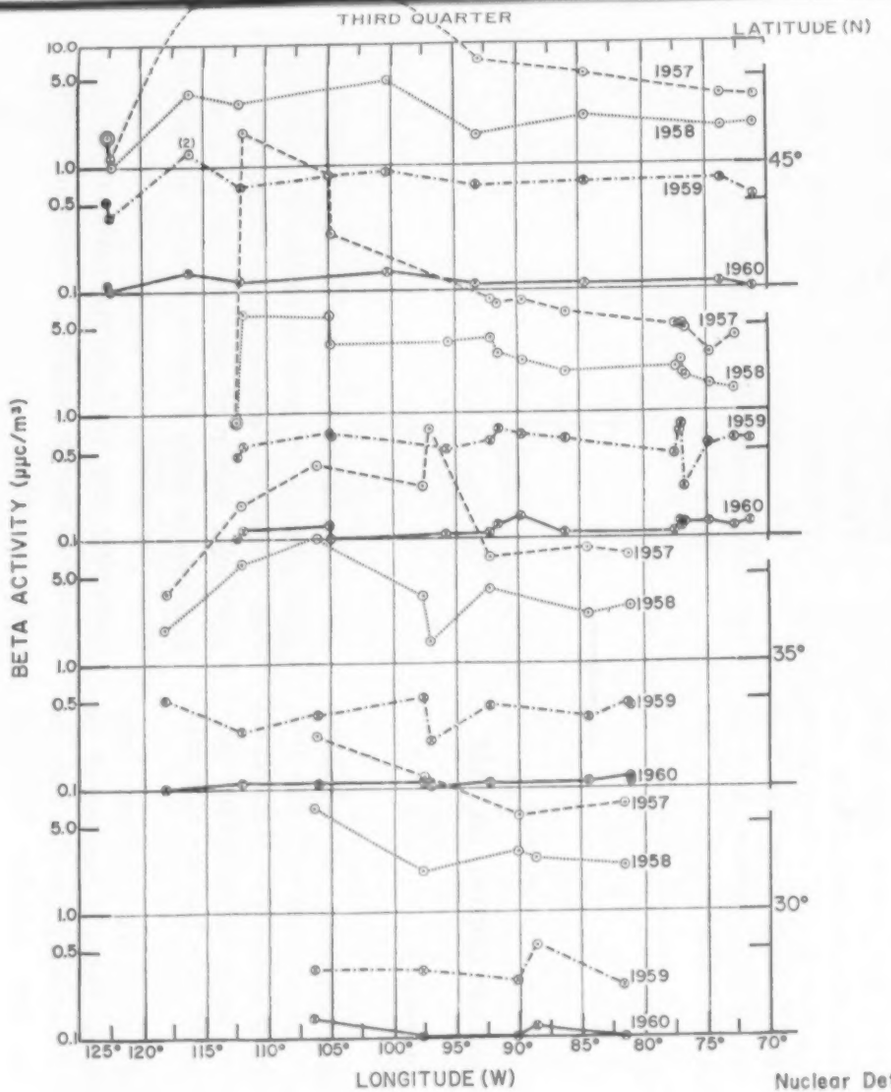
Figure 2 is a presentation of quarterly average surface-air measurements made at stations located in latitude class intervals whose midpoints are 30°, 35°, 40°, and 45° North. Each quarter is shown as four separate graphs to illustrate variations in surface-air fission product gross beta concentrations (ordinate-logarithmic) as a function of longitude, West (abscissa-linear).

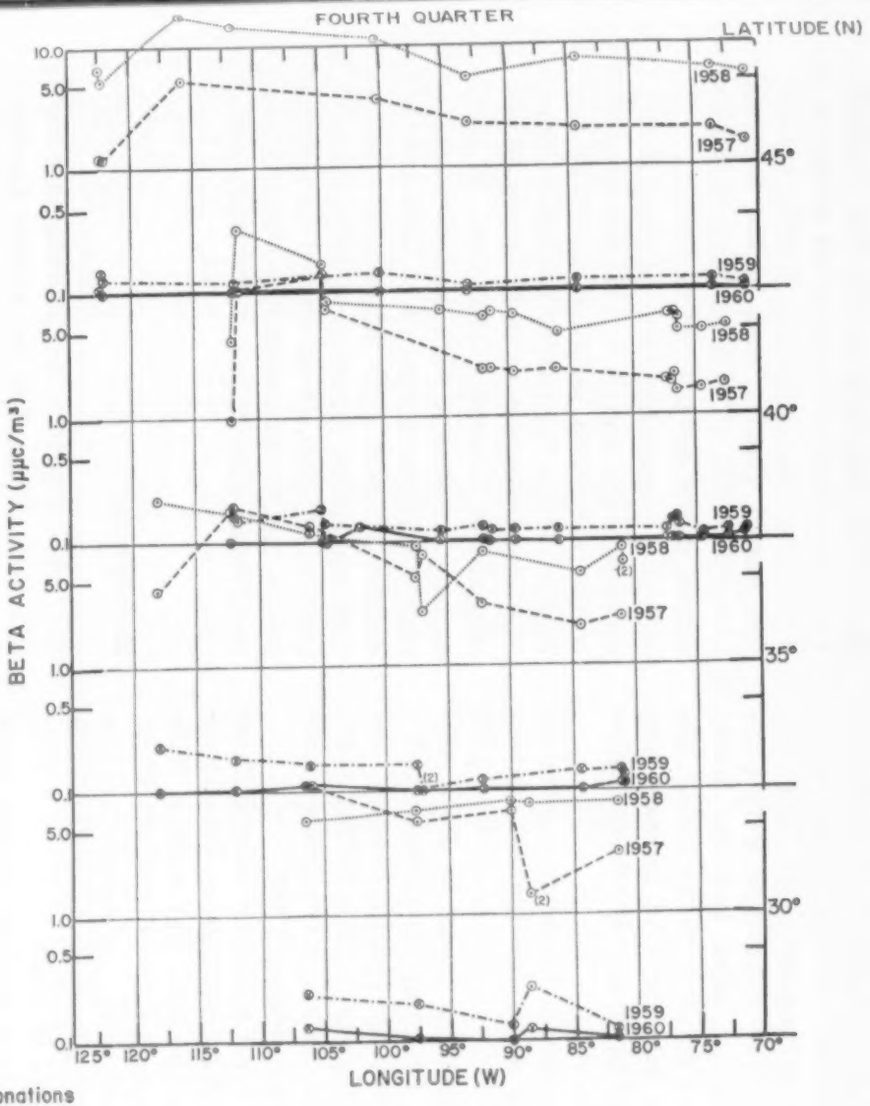
Data for the years 1957–1960 are shown in each quarter with the exception of the first. A graphical presentation was impossible in this case because of insufficient data. Data for stations located in Anchorage, Juneau, and Fairbanks, Alaska, and Honolulu, Hawaii, were not incorporated into figure 4, since the latitudes of these four stations do not correspond to those presented in this figure.

Quarterly averages with at least one month's data having a value less than the minimum detectable activity (0.10 $\mu\mu c/m^3$) are presented as an "X" within a circle. In such cases, the minimum detectable activity was used for the purpose of computing a quarterly average. Therefore, an "X" within a circle represents the maximum possible average for a particular quarter.

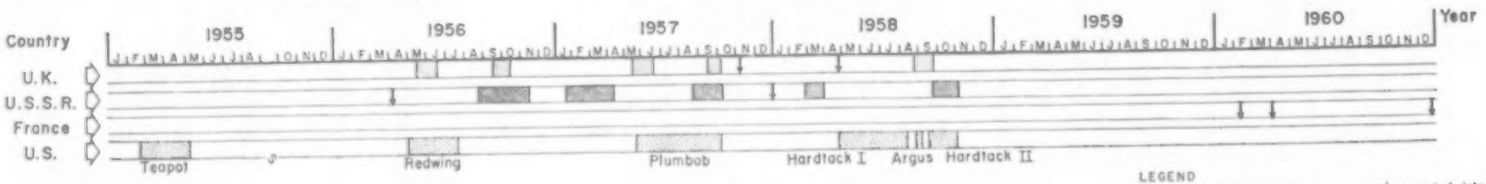
FIGURE 2.—SURFACE AIR GROSS BETA DETERMINATIONS A PRESENTATION OF QUARTERLY DATA DERIVED FROM SELECTED SAMPLING STATIONS LOCATED IN THE U.S.A. NEAR THE 30th, 35th, 40th AND 45th LATITUDES (N)







Nuclear Detonations



LEGEND
(1) Quarterly average based on one month's reported data.
(2) Quarterly average based on two month's reported data.
(⊗) Quarterly average with at least one month's data having a "less than" (<) value. Actual "less than" value used for computation.
(⊙) Three month quarterly average without "less than" values; Minimum detectable activity: 0.10 μμc/m³

Certain trends are revealed by a qualitative examination of the yearly data by quarters. In the first quarter, surface-air gross beta concentrations along all four latitudes were highest in 1959, lower in 1958, and the lowest concentrations were encountered in 1960. The limited amount of data for 1957 indicate that concentrations for that year fell between those for 1958 and 1960.

In the second quarter, from approximately 80°–100° longitude West, the highest concentrations occurred during 1959 and 1958, with concentrations somewhat lower in 1957, and lowest in 1960. From approximately 100°–120° longitude West, the picture changes, the highest concentrations occurring during 1957.

Third quarter concentrations decreased progressively from 1957 through 1960.

Fourth quarter concentrations were highest in 1958. In general, concentrations were lower in 1957, except for the 30th and possibly 35th latitude from approximately 100°–120°, West, where they appear to be somewhat greater than 1958. The concentrations were still lower in 1959, and minimal in 1960.

An analysis of fission product surface gross beta measurements, for the period 1957–1960, reveals that the highest concentrations occurred in the third quarter of 1957; the highest concentrations in 1958, which were less than 1957, occurred in the fourth quarter; and the highest concentrations in 1959, which were less than 1958, occurred in the first quarter. In 1960, maximum concentrations along the 35th, 40th, and 45th latitudes, North, occurred in the second quarter, and in the first quarter along the 30th. The lowest concentrations occurred in the last quarter of 1960.

It is a reasonable assumption that the high concentrations shown in 1957 can be attributed to the Plumbbob series at the NTS and the Soviet tests in the earlier months of that year. The Soviet detonations in February–March and September–November 1958 are, in the same manner, related to high concentrations occurring in the fourth quarter of 1958 and the first quarter of 1959. The increase in debris in the first and second quarters of 1960, over the last quarter of 1959, is attributed to seasonal increase due to stratospheric deposition and to the French detonations of February and April 1960.

References

(1) AEC Quarterly Statements on Fallout.

(2) Joint Committee on Atomic Energy Congressional Hearings on Radioactive Fallout, Part I, 1957.

(3) *Radiological Health Data*, Vol. I, Numbers 1–9, 1960.

(4) *Radiological Health Data*, Vol. II, Numbers 1–4, 1961.

Radioactivity Measurements In Air

U.S. Naval Research Laboratory

Radioactivity measurements of air-filter samples collected at various sites near the 80th Meridian (West) are made by the U.S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

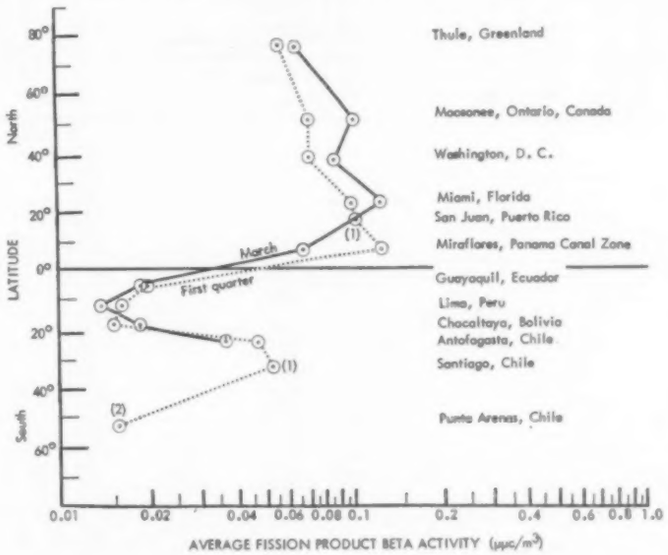
The daily record of fission product beta activity during March 1961 is presented in table 1, and the radioactivity profile for the same month and the first quarter 1961 are shown in figure 1. This figure illustrates the data plotted in semi-logarithmic coordinates. The ordinate is expressed in micromicrocuries per cubic meter of surface air. The concentrations in table 1 are expressed in disintegrations per minute per cubic meter of air at the collecting site (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

TABLE 1.—DAILY RECORD OF FISSION PRODUCT BETA ACTIVITY COLLECTED BY AIR FILTRATION, MARCH 1961

[Disintegrations per minute per cubic meter]

Day	Puerto Montt, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil Ecuador	Miraflores, Panama Canal Zone	Mauna Loa, Hawaii	Miami, Florida	Washington D. C.	Moosonee, Ontario, Canada	Thule, Greenland
1	----------	0.15	0.04	0.06	0.05	0.08	0.07	0.31	0.16	0.19	0.13
2	----------	0.20	0.03	0.04	0.07	0.09	0.10	0.08	0.13	0.20	0.20
3	----------	0.20	0.02	0.04	0.04	0.09	0.10	0.08	0.13	0.20	0.20
4	----------	0.03	0.02	0.03	0.04	0.13	0.24	0.12	0.20	0.22	0.13
5	----------	0.03	0.02	0.03	0.05	0.13	0.24	0.12	0.20	0.22	0.13
6	----------	0.03	0.02	0.03	0.05	0.13	0.24	0.12	0.20	0.22	0.13
7	----------	0.14	0.02	0.04	0.02	0.18	0.22	0.11	0.16	0.24	0.16
8	----------	0.14	0.02	0.04	0.02	0.18	0.22	0.11	0.16	0.24	0.16
9	----------	0.08	0.02	0.06	0.02	0.18	0.11	0.30	0.06	0.22	0.15
10	----------	0.08	0.02	0.06	0.03	0.18	0.11	0.30	0.06	0.22	0.15
11	----------	0.04	0.02	0.01	0.04	0.17	0.15	0.37	0.28	0.15	0.13
12	----------	0.04	0.02	0.01	0.04	0.17	0.15	0.37	0.28	0.15	0.13
13	----------	0.04	0.02	0.01	0.02	0.17	0.15	0.37	0.28	0.15	0.13
14	----------	0.07	0.07	0.03	0.02	0.24	0.25	0.27	0.14	0.30	0.18
15	----------	0.07	0.07	0.03	0.02	0.24	0.25	0.27	0.14	0.30	0.18
16	----------	0.04	0.07	0.01	0.02	0.24	0.20	0.31	0.22	0.29	0.17
17	----------	0.04	0.07	0.01	0.03	0.24	0.20	0.31	0.22	0.29	0.17
18	0.02	0.08	0.05	0.03	0.03	0.16	0.07	0.38	0.19	0.26	0.13
19	0.02	0.08	0.05	0.03	0.03	0.16	0.07	0.38	0.19	0.26	0.13
20	0.02	0.08	0.05	0.03	0.03	0.16	0.07	0.38	0.19	0.26	0.13
21	0.05	0.09	0.07	0.01	0.06	0.16	0.14	0.28	0.25	0.26	0.14
22	0.05	0.09	0.07	0.01	----------	0.16	0.14	0.28	0.25	0.26	0.14
23	0.04	0.07	0.02	0.04	0.10	0.09	0.06	0.31	0.10	0.29	0.08
24	0.04	0.07	0.02	0.04	0.06	0.09	0.06	0.31	0.10	0.29	0.08
25	0.11	0.06	----------	0.01	0.03	0.09	0.11	0.38	0.20	0.22	0.14
26	0.11	0.06	0.06	0.01	0.08	0.09	0.11	0.38	0.20	0.22	0.14
27	0.11	0.06	----------	0.01	0.06	0.09	0.11	0.38	0.20	0.22	0.14
28	0.07	0.10	0.02	0.06	0.08	0.10	0.08	0.31	0.30	0.09	0.16
29	0.07	0.10	0.02	0.06	0.05	0.10	0.08	0.31	0.30	0.09	0.16
30	0.03	0.10	0.02	0.04	0.05	0.18	0.45	0.30	0.27	0.29	0.17
31	0.03	0.10	0.02	0.04	----------	0.18	0.45	0.30	0.27	0.29	0.17
Mean value	0.05	0.08	0.04	0.03	0.04	0.15	0.16	0.28	0.19	0.23	0.14

FIGURE 1.—PROFILE OF BETA ACTIVITY, AVERAGE MEASUREMENTS OF SURFACE AIR AT STATIONS NEAR THE 80th MERIDAN (WEST), FIRST QUARTER AND MARCH 1961



(1) Average based on one month.
(2) Average based on two months.

Atmospheric Levels of Fission Product Gross Beta Activity Collected In Italy

Division of Biology and Sanitary Protection
Italian National Committee for Nuclear Energy

The information listed in table 2 summarizes the results of atmospheric fission product gross beta measurements made at ground level throughout Italy during the third and fourth quarters of 1960. Figure 1 illustrates the approximate geographic locations of the sampling stations referred to in table 2, and table 1 presents their respective coordinates and elevations.

Table 2 was compiled from data that appeared in Report number B10/03/61 entitled, "Data on Environmental Radioactivity, Collected in Italy (July–December 1960)" issued February 1961.

Similar data for the last two quarters of 1959 and the first two quarters of 1960 appeared in *Radiological Health Data,* Volume II, Number 6.

TABLE 1.—GROUND LEVEL FISSION PRODUCT GROSS BETA SAMPLING STATIONS–COORDINATES AND ELEVATIONS, ITALY

Station	Longitude	Latitude	Elevation (meters)	Station	Longitude	Latitude	Elevation (meters)
Alghero	8° 17′ 02″ E	40° 38′ 11″ N	21	Monte Scuro	16° 23′ 50″ E	39° 19′ 50″ N	1710
Ancona	13° 30′ 53″ E	43° 37′ 22″ N	105	Monte Terminillo	12° 59′ 06″ E	42° 27′ 36″ N	1874
Bari	16° 52′ 13″ E	41° 07′ 08″ N	4	Napoli "A"	14° 15′ 13″ E	40° 50′ 10″ N	42
Bologna	11° 19′ 44″ E	44° 29′ 12″ N	64	Napoli "B"	14° 15′ 22″ E	40° 50′ 50″ N	22
Brindisi	17° 56′ 30″ E	40° 39′ 30″ N	8	Padova	11° 52′ 38″ E	45° 24′ 30″ N	14
Casaccia	12° 15′ 58″ E	42° 02′ 25″ N	154	Palermo	13° 20′ 56″ E	38° 06′ 19″ N	9
Cozzo Spadaro	15° 07′ 59″ E	36° 41′ 04″ N	40	Pian Rosa'	7° 42′ 22″ E	45° 56′ 06″ N	3488
Elmas	9° 03′ 15″ E	39° 15′ 15″ N	18	Resina	14° 23′ 36″ E	40° 49′ 37″ N	608
Ferrania	8° 19′ 01″ E	44° 21′ 18″ N	363	Roma	12° 11′ 08″ E	41° 49′ 38″ N	72
Garigliano Foce	13° 50′ 03″ E	41° 15′ 43″ N	8	Saluggia	8° 01′ 25″ E	45° 13′ 05″ N	170
Genova	8° 55′ 21″ E	44° 25′ 08″ N	364	S. Donato Milanese			
Ispra	8° 37′ 35″ E	45° 48′ 11″ N	251	S. Giusto	10° 23′ 32″ E	43° 41′ 24″ N	5
Latina	12° 48′ 33″ E	41° 25′ 39″ N	6	S. Piero a Grado	10° 20′ 48″ E	43° 40′ 45″ N	3
Livorno	10° 18′ 29″ E	43° 31′ 35″ N	3	Sanremo	7° 49′ 45″ E	43° 49′ 12″ N	112
Messina	15° 33′ 13″ E	38° 12′ 00″ N	54	Tarvisio	13° 34′ 58″ E	46° 30′ 22″ N	777
Milano "A"	9° 11′ 27″ E	45° 27′ 59″ N	123	Trapani	12° 32′ 00″ E	37° 57′ 45″ N	71
Milano "B"	9° 11′ 27″ E	45° 27′ 59″ N	123	Trieste	13° 45′ 09″ E	45° 38′ 37″ N	8
Milano "C"	9° 11′ 27″ E	45° 27′ 59″ N	123	Verbania Pallanza	8° 33′ 06″ E	45° 55′ 25″ N	212
Monte Cimone	10° 41′ 55″ E	44° 11′ 35″ N	2173	Verona Villafranca	10° 53′ 24″ E	45° 23′ 37″ N	73
Monte Paganella	11° 02′ 13″ E	46° 08′ 35″ N	2125	Vigna di Valle	12° 13′ 00″ E	42° 04′ 45″ N	270
Monte S. Angelo	15° 56′ 53″ E	41° 42′ 28″ N	838				

FIGURE 1.—SAMPLING STATIONS FOR THE DETERMINATION OF FISSION BETA RADIOACTIVITY IN AIR AT GROUND LEVEL

TABLE 2.—FISSION PRODUCT GROSS BETA ACTIVITY IN AIR AT GROUND LEVEL, 1960

[Average concentrations in $\mu\mu c/m^3$]

Station	Third quarter	Fourth quarter	Yearly average	Station	Third quarter	Fourth quarter	Yearly average
Alghero	0.09	<0.05	[3] <0.13	Monte Scuro	0.11	0.07	0.13
Ancona	[1] 0.08	0.05	[4] 0.60	Monte Terminillo	0.11	0.05	0.10
Bari	0.09	<0.04	[3] <0.09	Napoli "A"	0.10	<0.05	[3] <0.09
Bologna	0.11	<0.04	[3] <0.09	Napoli "B"	0.11	0.04	0.11
Brindisi	0.06	0.06	[5] 0.09	Padova	[2] 0.05	0.02	[5] 0.06
Casaccia	0.13	0.04	0.11	Palermo	0.10	<0.05	[3] <0.10
Cozzo Spadaro	0.08	<0.05	[2,6] <0.10	Pian Rosa'	0.10	0.06	0.18
Elmas	0.10	0.05	0.17	Resina	0.09	<0.04	[3] <0.09
Ferrania	0.03	0.02	0.04	Roma	0.08	0.04	[5] 0.07
Garigliano Foce	0.45	0.18	[5] 0.28	Saluggia	0.13	0.03	[5] 0.10
Genova	0.08	<0.04	[3] <0.13	S. Donato Milanese			[5] 0.07
Ispra	0.07	0.03	0.09	S. Giusto	0.08	0.04	0.07
Latina	0.42	0.14	0.99	S. Piero a Grado	0.08	0.05	0.08
Livorno	0.08	0.03	0.06	Sanremo	[1] 0.08	0.06	[4] 0.07
Messina	0.11	0.07	0.11	Tarvisio	0.08	0.06	[9] 0.07
Milano "A"	0.07	0.05	0.07	Trapani	0.08	0.05	0.09
Milano "B"	[2] 0.08	0.03	[6] 0.08	Trieste	0.08	<0.04	[3] <0.08
Milano "C"	0.11	0.05	0.10	Verbania Pallanza	0.08	<0.04	[3] <0.08
Monte Cimone	0.11	0.06	0.11	Verona Villafranca	0.09	0.06	[9] 0.08
Monte Paganella		0.06	[7] 0.06	Vigna di Valle	0.12	0.06	0.10
Monte S. Angelo	0.07	0.05	0.08				

[1] Based on measurements made in August and September.
[2] Based on measurements made in July and September.
[3] Indicates that at least one month's data was preceded by a less than sign (<). In these cases, the actual "less than value" was used for the purpose of computing both the quarterly and yearly averages.
[4] Based on measurements made in August through December.
[5] Based on measurements made in February through December
[6] Based on measurements made in January through July, and September through December.
[7] Based on measurements made in October through December.
[8] Based on measurements made in January through June.
[9] Based on measurements made in July through December.

Canadian Radioactive Fallout Study Program

Department of National Health and Welfare,
Dominion of Canada

As part of its Radioactive Fallout Study Program, the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, conducts air and precipitation sampling programs.

The nation-wide air sampling program is conducted for two main purposes: (1) to provide a convenient method for the early detection of changes in fission product concentration in air and therefore of likely changes in the deposition of fission products on the ground, and (2) to obtain data to show the day-to-day and station-to-station variations. This may be useful to meteorologists in a better understanding of the mechanisms involved in radioactive fallout distribution in the atmosphere.

A more detailed discussion of the sampling procedures, methods for analyses and interpretation of results of the Department's radioactive fallout program is contained in the "Annual Report for 1959," Report Number CNHW (RP–3).

TABLE 1.—TOTAL BETA RADIOACTIVITY IN AIR, FOURTH QUARTER 1960

[Average concentrations in dpm/m³]

Station locaion	October	November	December
Aklavik	0.10	0.18	0.19
Calgary	0.18	0.19	0.24
Chatham	0.15	0.15	0.19
Coral Harbour	0.11	0.18	0.21
Edmonton	0.17	0.22	0.24
Fort Churchill	0.07	0.19	0.18
Fort Williams	0.19	0.14	0.24
Fredericton	0.11	0.12	0.18
Kapuskasing	0.17	0.13	0.24
Montreal	0.19	0.16	0.23
Moosonee	0.15	0.16	0.26
Ottawa	0.20	0.20	0.23
Regina	0.17	0.26	0.28
Resolute	0.07	0.24	0.24
Saskatoon	0.17	0.19	0.26
Shearwater	0.17	0.16	0.22
Torbay	0.11	0.14	0.16
Toronto	0.19	0.19	0.25
Vancouver	0.12	0.11	0.14
Whitehorse	0.13	0.19	0.14
Windsor	0.27	0.23	0.25
Winnipeg	0.18	0.20	0.30
Yellowknife	0.11	0.23	0.24

Radiological Health Data, Volume II, Numbers 1 and 4 presented data on total beta activity in air and precipitation for the periods July 1959–June 1960 and the third quarter of 1960 respectively. With the permission of the Department of National Health and Welfare, Dominion of Canada, similar data are presented in tables 1, 2, and 3 for the fourth quarter of 1960.

TABLE 2.—MONTHLY AVERAGE FISSION PRODUCT CONCENTRATION IN AIR, FOURTH QUARTER 1960

[Average concentrations in dpm/m³]

Month	Number of stations operating 50% of the time	Minimum average all stations	Maximum average all stations	Overall average
October	22	0.07	0.27	0.15
November	22	0.11	0.24	0.18
December	22	0.14	0.30	0.22

TABLE 3.—TOTAL BETA RADIOACTIVITY IN PRECIPITATION, FOURTH QUARTER 1960

Station location	October		November		December	
	μμc/liter	inches	μμc/liter	inches	μμc/liter	inches
Aklavik	9.1	1.49	4.6	3.80	6.1	3.90
Calgary	31.9	0.78	54.7	0.50	31.9	0.69
Chatham	10.6	3.55	12.2	4.26	10.7	4.38
Coral Harbour	42.6	0.85	1.5	1.31	242.2	0.52
Edmonton	27.4	1.66	47.1	0.69	22.8	1.06
Fredericton	22.8	3.41	12.1	5.34	15.2	3.91
Fort Churchill	21.3	2.26	18.2	2.18	47.1	0.75
Fort Williams	25.8	3.18	24.4	2.00	74.5	0.41
Goose Bay	13.7	2.82	13.7	1.84	12.2	2.02
Kapuskasing	18.2	2.93	12.2	3.51	12.2	1.80
Montreal	10.6	4.54	24.4	3.46	9.1	4.77
Moosonee	7.6	2.67	6.1	4.68	24.3	1.28
Ottawa	13.7	2.95	21.3	2.17	28.9	1.63
Regina	----------	trace	3.0	0.54	98.8	0.31
Resolute	----------	NS [1]	----------	NS	----------	NS
Saskatoon	63.8	0.24	53.2	0.43	85.1	0.54
Shearwater	35.0	2.20	36.5	2.17	16.7	3.18
Torbay	6.1	7.21	7.6	5.16	10.6	5.23
Toronto	38.0	2.40	22.8	2.91	74.5	0.77
Vancouver	12.1	8.20	15.2	5.55	9.1	5.42
Whitehorse	48.6	0.98	173.3	0.43	19.8	0.47
Windsor	35.0	1.61	28.9	1.17	18.3	0.71
Winnipeg	22.8	1.84	123.6	0.48	10.6	0.75
Yellowknife	16.7	2.59	13.7	1.86	10.6	0.72
Average	24.2	----------	31.8	----------	40.1	----------

[1] NS—No sample.

SECTION II. — FOOD, OTHER THAN MILK

Survey of Radioactivity In Food

Food and Drug Administration

The Food and Drug Administration conducts a continuing surveillance to determine the concentrations of certain radionuclides in a variety of different food items, domestic and foreign. *Radiological Health Data,* Volume II, Number 1 presented data on the gross beta radioactivity in foods. Table 1 presents some partial results on bulk food commodities collected from 12 major growing areas, table 2, the preliminary results of a survey of baby foods, and table 3, some results on spot checking of fruits and vegetables and other items. These samples were collected by representatives of Food and Drug Administration Districts.

TABLE 1.—RADIOANALYSES OF SELECTED RAW AGRICULTURAL PRODUCTS HARVESTED IN 1960

[Concentrations in $\mu\mu c$/kg original material]

Raw agricultural product	Area		Strontium-90	Cesium-137
	County	State		
Cabbage	Fannin	Ga.	25	<5
Potatoes	Fannin	Ga.	6	291
Wheat	Barton	Ga.	17	25
Potatoes	Accomack	Va.	3	<6
Wheat	Accomack	Va.	46	120
Cabbage	Clinton	Ohio	13	80
Potatoes	Clinton	Ohio	3	<6
Wheat	Clinton	Ohio	50	24
Wheat	Clinton	Ohio	50	20
Wheat	Taylor & Callahan	Texas	7	25
Wheat	Placer & Sacramento	Calif.	7	
Potatoes	San Joaquin	Calif.	0.4	
Wheat	Johnson	Kansas	18	
Wheat	Walla Walla	Wash.	3	

TABLE 2.—RADIOANALYSES FOR STRONTIUM-90 IN SELECTED BABY FOODS

[Concentration in $\mu\mu c$/kg original material]

Product	Place grown or processed	Date harvested or processed	Strontium-90
Strained peaches	Stanislaus, Calif.	1960	0.1
Strained peaches	Calif.[1]	1960	0.2
Strained peaches	Berrien, Mich.	Aug. 1960	1.2
Strained plums	Calif.[1]	Sept. 1960	0.7
Strained pears	Berrien, Mich.	Aug. 29, 1960	3.9
Strained apricots w/tapioca.	Contra Costa, Calif.	June 1960	0.2
Strained creamed spinach.	Muskegan, Mich.	May 1, 1960	11.0
Strained peas	Saginaw & Mecasta, Mich.	July 19, 1960	3.8
Strained squash	Henderson, N.C.	Aug. 15, 1960	18.0
Beef & b. broth	St. Paul, Minn.[1]	Apr. 13, 1960	1.4
Veal & v. broth	St. Paul, Minn.[1]	Apr. 7, 1960	0.8
Oat flour	Cedar Rapids, Iowa [1]	July 1960	11.0
Soya flour	Chicago, Ill.[1]	July 1960	25.0
Wheat germ	Minneapolis, Minn.[1]	July 1960	46.0

[1] Denotes processing location and date.

TABLE 3.—RADIOANALYSES FOR STRONTIUM-90 IN FRUITS, VEGETABLES AND MISCELLANEOUS ITEMS

[Concentrations in $\mu\mu$c/kg original material]

Product	Area		Date harvested or processed	Strontium-90
	County	State or country		
Fresh tomatoes	Morgan	W.Va.	Sept. 1, 1960	2.6
Fresh tomatoes	Roanoke	Va.	Aug. 31, 1960	1.9
Fresh tomatoes	Miami	Ohio	Sept. 8, 1960	9.9
Fresh tomatoes	Wicomico	Md.	Sept. 1, 1960	2.0
Fresh tomatoes	Northumberland	Va.	Aug. 25, 1960	2.8
Fresh tomatoes	Westmorland	Va.	Aug. 25, 1960	3.4
Canned tomatoes	Roanoke	Va.	Aug. 31, 1960	1.5
Fresh peaches	Rappahanock	Va.	Aug. 20, 1960	1.6
Canned peaches	Rappahanock	Va.	Aug. 20, 1960	0.9
Dried peaches	Santa Clara	Calif.	1960	3.2
Fresh wax beans	Dorchester	Md.	Sept. 7, 1960	7.2
Canned green beans	Erie	N.Y.	Sept. 12, 1960	2.4
Lettuce	Steuben	N.Y.	Sept. 13, 1960	2.6
Asparagus	----------	N.J.	1960	10.0
Canned tuna fish	----------	Japan	1959?	0.1
Canned tuna fish	----------	Japan	1960?	0.3
Cheddar cheese	Erie	N.Y.	Sept. 13, 1960	43.0
Lawn grass (6 lbs collected from area 15′ × 60′).	Montgomery	Md.	July 18, 1960	145.0

SECTION III. — MILK

Milk Monitoring Program

Division of Radiological Health, Public Health Service

There are two Public Health Service Milk Monitoring Programs. The original network consisted of five milkshed sampling stations. It was later expanded to twelve stations, nine of which are still active. Raw milk is spot sampled at these stations. During 1960 a processed milk sampling program of 60 stations was established. Since the sampling procedures for the raw milk sampling stations and the processed milk area sampling stations are different, they are described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations; the Public Health Service Southeastern Radiological Health Laboratory at Montgomery, Alabama, and the Southwestern Radiological Health Laboratory at Las Vegas, Nevada, provide analytical services for the new program.

The purposes of the two sampling programs are not the same. The original network was established to develop sampling and radiochemical analytical proficiencies under conditions which would remain similar over a period of time in regard to the source of milk. During the operation of this program it became apparent that a broader sampling program, more directly related to the milk consumed by the population, was necessary. The Public Health Service, Department of Health, Education, and Welfare, acted to provide facilities for this change. This resulted in the transition from the program of sampling raw milk, collected from milksheds of limited size, to a sampling program designed to be representative of the processed milk consumed in a given municipality.

In some instances, the newly designated stations are the same as those which were reported originally. The establishment of the new processed milk area sampling stations does not preclude the need for further raw milk sampling from the selected milkshed serving the same city. It is important that both networks be in operation for a sufficient period of time to provide an overlap for the purpose of comparative study.

Because of the different sources of these samples, changes in the method of collecting samples, and the utilization of different laboratory techniques, differences were anticipated in the amounts of radioactivity found in the milk under the two programs. For this reason, an investigation to determine the comparability of the two programs was begun in January 1961. This investigation covers many factors including laboratory methodology and collection methods. Until this study has been completed and additional experience has been

gained under the new program, no valid interpretation can be made of any differences of radioactivity in milk samples collected under the two systems.

Publication of the data from each program will normally follow about four months after sample collection because of the time required for shipment, processing, decay product buildup, compilation of the data, and clearance and publication procedures.

Raw Milk Sampling Stations

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Public Health Service to determine trends in our changing environment with respect to measuring the amounts of radioactivity in water, air, milk, and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop effective collection systems and radiochemical analysis procedures which would make them more suitable for larger scale programs.

The criteria on which the selection of the original sampling stations was based appeared in the discussion sections of all Volume I issues of *Radiological Health Data.*

One-gallon raw milk samples are collected from a dairy company once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center for radionuclide analyses. These samples represent between 2,000- and 90,000-gallon lots. The concentration of iodine-131, barium-140, and cesium-137 are currently being measured by gamma scintillation spectroscopy. Total radiostrontium and strontium-90 are determined following radiochemical separations. The amount of strontium-90 is calculated by measuring the buildup of the strontium-90 daughter decay product, yttrium-90, over a two-week period. Measurements are made in a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter. The difference between the total strontium and strontium-90 is reported as strontium-89. Stable calcium is also determined.

The April through September 1960 issues of *Radiological Health Data* list references for technical descriptions of analytical procedures.

Tables 1 through 6 present quarterly averages for each radioisotope and stable calcium for 1957–1960, and the first quarter of 1961. Data for March 1961 are also included.

Processed Milk Area Sampling Stations

The processed milk surveillance program will provide additional information on levels of radioactivity in milk consumed by the public. The new stations have been established in cooperation with State and local health and milk sanitation agencies. Each city has been selected to provide adequate coverage with respect to production areas and the consuming population. The emphases on this expanded sampling and radioassay program are:

1. to measure the levels of radioactivity of the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the processing plant, and
2. to provide one sampling point within each State with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of large population groups.

The new network was designed to sample processed milk rather than the raw product. The sampling procedure was developed to provide a sample from one day's sales per month in a community which would be as representative of the total supply as can be achieved under practical conditions. Each sample is a composite of those plants supplying not less than 90 percent of a city's milk supply. The contribution from each plant to the total sample is approximately proportional to the volume of milk sold.

The samples from the new stations are collected with the assistance of the various State and local health and milk sanitation agencies and are shipped for analyses to either the Southwestern or Southeastern Radiological Health Laboratory. The Southeastern Radiological Health Laboratory processes samples

from the 30 states generally east of the Mississippi, and the Southwestern Radiological Health Laboratory processes samples from the western states. Figure 1 shows the locations of these stations.

At the present time radioassays for Sr^{90}, Cs^{137}, Sr^{89}, Ba^{140} and I^{131} are being performed. The latter three radionuclides are not presently found in milk by the current methods of detection. The lower level of detection for Sr^{89} is 5 μμc/liter, and Ba^{140} and I^{131}, 10 μμc/liter. Other radionuclides of concern to public health agencies will be included for assay as necessary for a more complete monitoring of the milk supply.

Tables 7, 8, and 9 present quarterly averages for strontium-90, cesium-137, and stable calcium, respectively, for 1960 and the first quarter of 1961. Data for March 1961 are also included.

TABLE 1.—TABULATION OF RESULTS, STRONTIUM-90 DETERMINATIONS, RAW MILK SAMPLING STATIONS, 1957–1961

[Concentrations in μμc/liter]

Area	1957			1958				1959				1960				1961	
	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	March
Atlanta, Ga					14	12	10	12	21	15	14	17	16	13	12	13	11
Austin, Tex					2	4	3	6	7	4	5	6	4	3	4	4	4
Chicago, Ill						8	7	6	11	9	9	9	12	8	8	6	8
Cincinnati, O	[2] 6	5	7	4	9	10	11	12	17	10	12	12	11	9	8	8	8
Fargo, N.D.—Moorehead, Minn					[1] 15	14	13	12	16	15	14	[1] 11					
New York, N.Y	[2] 5	7	5	5	6	6	9	7	11	10	9	10	11	9	8	9	7
Overton, Nev								[1] 4	4	2	3	4	3	[1] 2			
Sacramento, Calif	[2] 6	2	5	5	7	5	4	5	7	3	5	3	4	4	2	5	3
Salt Lake City, Utah	[2] 6	4	4	3	5	5	5	4	9	7	6	8	8	5	4	4	2
Spokane, Wash						[2] 8	10	9	18	10	12	13	16	9	7	7	8
St. George, Utah								[1] 6	6	[2] 3	3	4					
St. Louis, Mo	[2] 12	8	9	8	12	16	16	20	28	17	24	20	22	16	14	13	13
Network average	7	5	6	5	9	9	9	9	13	9	10	10	11	8	8	8	7

[1] Average based on one month.
[2] Average based on two months.

TABLE 2.—TABULATION OF RESULTS, STRONTIUM-89 DETERMINATIONS, RAW MILK SAMPLING STATIONS 1957–1961

[Concentrations in μμc/liter]

Area	1957			1958				1959				1960				1961	
	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	March
Atlanta, Ga					[1] 35	75	45	75	90	15	<5	<5	<5	<5	<5	<5	<5
Austin, Tex					[1] 25	30	40	45	45	5	<5	<5	<5	<5	<5	<5	<5
Chicago, Ill						70	45	<5	30	10	<5	<5	<5	<5	<5	<5	<5
Cincinnati, O		[2] 75	65	<5	65	130	65	20	40	10	<5	<5	<5	<5	<5	<5	<5
Fargo, N.D.—Moorehead, Minn					[1] 80	110	80	20	25	20	<5	[1] <5					
New York, N.Y		[2] 80	55	<5	30	65	50	5	20	10	<5	<5	<5	<5	<5	<5	<5
Overton, Nev								[1] 5	<5	<5	<5	<5	<5	[1] <5			
Sacramento, Calif		[2] 20	15	5	50	20	15	30	25	<5	<5	<5	<5	<5	<5	<5	<5
Salt Lake City, Utah		[2] 65	45	5	30	40	15	5	20	5	<5	<5	<5	<5	<5	<5	<5
Spokane, Wash						[2] 55	35	15	50	20	<5	<5	<5	<5	<5	<5	<5
St. George, Utah								[1] <5	15	[2] <5	<5	<5					
St. Louis, Mo		[2] 160	80	20	90	285	130	95	125	15	5	<5	<5	<5	<5	<5	<5
Network average		80	50	5	50	90	50	30	40	10	<5	<5	<5	<5	<5	<5	<5

[1] Average based on one month.
[2] Average based on two months.

TABLE 3.—TABULATION OF RESULTS, CESIUM-137 DETERMINATIONS, RAW MILK SAMPLING STATIONS, 1957–1961

[Concentrations in μμc/liter]

Area	1957			1958				1959				1960				1961	
	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	March
Atlanta, Ga	------	------	------	------	[1] 120	100	70	85	120	90	45	60	45	25	15	25	30
Austin, Tex	------	------	------	------	[1] 70	50	40	50	65	50	20	30	20	10	5	10	15
Chicago, Ill	------	------	------	------	------	90	65	65	70	60	35	40	40	20	15	20	20
Cincinnati, O	[2] 30	45	40	55	60	80	60	60	70	40	30	40	20	15	15	15	25
Fargo, N.D.—Moorehead, Minn	------	------	------	------	[1] 110	120	65	65	75	65	45	[1] 45	------	------	------	------	------
New York, N.Y	[2] 35	45	45	40	50	80	60	65	65	55	30	45	35	10	15	20	20
Overton, Nev	------	------	------	------	------	------	------	[1] 30	35	40	15	20	10	[1] 10	------	------	------
Sacramento, Calif	[2] 35	55	40	45	80	65	45	45	60	55	15	15	10	5	10	10	20
Salt Lake City, Utah	[2] 40	50	45	60	55	45	35	35	50	40	35	45	40	15	10	10	20
Spokane, Wash	------	------	------	------	------	[2] 85	75	75	85	60	60	55	45	25	20	15	20
St. George, Utah	------	------	------	------	------	------	------	35	45	[2] 30	15	20	------	------	------	------	------
St. Louis, Mo	[2] 45	55	50	45	85	125	75	80	120	80	40	40	35	20	20	25	30
Network average	35	50	45	50	80	85	60	60	70	60	30	40	30	15	15	15	20

[1] Average based on one month.
[2] Average based on two months.

TABLE 4.—TABULATION OF RESULTS, IODINE-131 DETERMINATIONS, RAW MILK SAMPLING STATIONS, 1957–1961

[Concentrations in μμc/liter]

Area	1957			1958				1959				1960				1961	
	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	March
Atlanta, Ga	------	------	------	------	[1] <10	40	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Austin, Tex	------	------	------	------	[1] <10	30	80	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chicago, Ill	------	------	------	------	------	60	30	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cincinnati, O	[1] 370	[2] 330	110	<10	10	50	70	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fargo, N.D.—Moorehead, Minn	------	------	------	------	[1] <10	60	40	<10	<10	<10	<10	[1] <10	------	------	------	------	------
New York, N.Y	[1] 40	[2] 175	175	<10	30	50	40	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Overton, Nev	------	------	------	------	------	------	------	[1] <10	<10	<10	<10	<10	<10	[1] <10	------	------	------
Sacramento, Calif	[1] 250	[2] <10	<10	<10	80	30	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Salt Lake City, Utah	[1] 440	[2] 470	350	10	10	80	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Spokane, Wash	------	------	------	------	------	[2] 40	35	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
St. George, Utah	------	------	------	------	------	------	------	[1] <10	[2] <10	<10	<10	<10	------	------	------	------	------
St. Louis, Mo	[1] 410	[2] 590	290	<10	30	235	60	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Network average	300	310	185	<10	35	85	40	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

[1] Average based on one month.
[2] Average based on two months.

TABLE 5.—TABULATION OF RESULTS, BARIUM-140 DETERMINATIONS, RAW MILK SAMPLING STATIONS, 1957–1961

[Concentrations in μμc/liter]

Area	1957			1958				1959				1960				1961	
	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	March
Atlanta, Ga	------	------	------	------	[1] <10	20	<10	20	<10	<10	<10	<10	<10	<10	<10	<10	<10
Austin, Tex	------	------	------	------	[1] <10	<10	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chicago, Ill	------	------	------	------	------	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cincinnati, O	------	[2] 110	30	<10	20	70	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fargo, N.D.—Moorehead, Minn	------	------	------	------	[1] 20	40	20	<10	<10	<10	<10	[1] <10	------	------	------	------	------
New York, N.Y	------	[2] 100	50	<10	<10	30	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Overton, Nev	------	------	------	------	------	------	------	[1] <10	<10	<10	<10	<10	<10	[1] <10	------	------	------
Sacramento, Calif	------	20	40	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Salt Lake City, Utah	[1] 70	110	50	<10	10	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Spokane, Wash	------	------	------	------	------	[2] 10	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
St. George, Utah	------	------	------	------	------	------	------	[1] <10	<10	[2] <10	<10	<10	------	------	------	------	------
St. Louis, Mo	[1] 90	240	50	<10	40	130	30	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Network average	80	120	40	<10	10	35	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

[1] Average based on one month.
[2] Average based on two months.

TABLE 6.—TABULATION OF RESULTS, STABLE CALCIUM DETERMINATIONS, RAW MILK SAMPLING STATIONS, 1957–1961

[Concentrations in μμc/liter]

Area	1957			1958				1959				1960				1961	
	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	March
Atlanta, Ga.	------	------	------	------	[1] 1.16	1.17	1.21	1.24	1.23	1.14	1.11	1.16	1.10	1.09	1.19	1.18	1.15
Austin, Tex.	------	------	------	------	[1] 1.12	1.14	1.17	1.18	1.04	1.08	1.09	1.14	1.06	1.06	1.17	1.16	1.12
Chicago, Ill.	------	------	------	------	------	1.11	1.12	1.11	1.14	1.06	1.09	1.08	1.12	1.05	1.15	1.17	1.15
Cincinnati, O.	[2] 1.15	1.15	1.19	1.14	1.18	1.11	1.16	1.15	1.16	1.11	1.12	1.08	1.19	1.04	1.22	1.21	1.18
Fargo, N.D.—Moorehead, Minn.	------	------	------	------	[1] 1.11	1.13	1.18	1.13	1.15	1.11	1.08	[1] 1.22	------	------	------	------	------
New York, N.Y.	[2] 1.03	1.04	1.11	1.09	1.07	1.11	1.12	1.09	1.13	1.03	1.06	1.07	1.12	1.05	1.15	1.11	1.11
Overton, Nev.	------	------	------	------	------	------	------	[1] 1.10	1.08	1.04	1.09	1.09	1.11	[1] 0.98	------	------	------
Sacramento, Calif.	[2] 1.11	1.10	1.15	1.15	1.14	1.11	1.13	1.15	1.14	1.08	1.09	1.09	1.12	1.09	1.21	1.19	1.19
Salt Lake City, Utah	[2] 1.12	1.12	1.17	1.14	1.13	1.13	1.17	1.16	1.12	1.08	1.11	1.11	1.09	1.05	1.20	1.19	1.23
Spokane, Wash.	------	------	------	------	------	[2] 1.17	1.22	1.23	1.17	1.16	1.12	1.15	1.07	1.09	1.21	1.22	1.18
St. George, Utah	------	------	------	------	------	------	------	[1] 1.16	1.12	[2] 1.06	1.08	1.08	------	------	------	------	------
St. Louis, Mo.	[2] 1.20	1.20	1.29	1.30	1.24	1.25	1.28	1.28	1.27	1.19	1.27	1.30	11.7	1.11	1.29	1.26	1.24
Network average	1.12	1.12	1.18	1.16	1.15	1.14	1.18	1.17	1.15	1.10	1.11	1.13	1.12	1.05	1.20	1.19	1.17

[1] Average based on one month.
[2] Average based on two months.

FIGURE 1.—PROCESSED MILK AREA SAMPLING STATIONS

TABLE 7.—SUMMARY OF RESULTS, STRONTIUM-90 DETERMINATIONS, PROCESSED MILK AREA SAMPLING STATIONS, 1960–1961

[Average concentrations in $\mu\mu c$/liter]

Area	1960				1961	
	First quarter	Second quarter	Third quarter	Fourth quarter	First quarter	March
Albuquerque, N.Mex.	[1] 3	5	4	4	5	4
Atlanta, Ga.		[2] 11	9	7	6	
Austin, Tex.		[1] 2	2	[2] 2	2	2
Baltimore, Md.			[2] 7	8	6	6
Boston, Mass.		[1] 16	12	10	8	7
Buffalo, N.Y.		6	7	18	[2] 6	(3)
Burlington, Vt.		10	9	7	9	8
Charleston, S.C.			[2] 10	11	8	10
Charleston, W.Va.		9	10	8	5	6
Charlotte, N.C.		[1] 14	12	11	9	8
Chattanooga, Tenn.			[1] 11	10	8	6
Chicago, Ill.			7	5	[2] 6	(3)
Cincinnati, Ohio			9	7	7	7
Cleveland, Ohio			8	7	6	6
Dallas, Tex.		[1] 8	6	6	5	6
Denver, Colo.	[1] 8	8	5	7	6	8
Des Moines, Iowa		[1] 8	7	[2] 8	7	8
Detroit, Mich.			7	7	6	6
Grand Rapids, Mich.			8	7	7	6
Hartford, Conn.		9	8	9	7	8
Helena, Mont.		[1] 9	6	6	4	2
Honolulu, Hawaii		3	6	4	4	3
Idaho Falls, Idaho	[1] 4	7	5	5	5	5
Indianapolis, Ind.			6	6	7	8
Jackson, Miss.			[2] 12	11	10	8
Kansas City, Mo.		8	7	8	7	7
Laramie, Wyo.		6	5	5	5	6
Las Vegas, Nev.	[1] 3	3	2	3	3	5
Little Rock, Ark.			[2] 13	[2] 13	13	14
Louisville, Ky.		7	10	9	7	6
Manchester, N.H.		13	11	9	8	8
Memphis, Tenn.			[1] 14	9	8	10
Milwaukee, Wis.			6	6	5	5
Minneapolis, Minn.			[2] 9	8	7	9
New Orleans, La.			16	11	8	8
New York, N.Y.		[1] 11	9	8	[2] 7	8
Norfolk, Va.			9	9	[2] 7	(3)
Oklahoma City, Okla.			8	7	5	4
Omaha, Nebr.			[2] 8	6	7	9
Palmer, Alaska	[1] 5	8	7	7	6	7
Philadelphia, Pa.		10	9	6	7	7
Phoenix, Ariz.			4	4	2	2
Pittsburgh, Pa.		15	11	11	9	10
Portland, Me.		[1] 15	11	9	[2] 10	(3)
Portland, Oreg.		11	10	9	8	9
Providence, R.I.		[1] 18	11	9	9	9
Sacramento, Calif.			[2] 5	5	3	4
Salt Lake City, Utah	[1] 8	7	4	5	4	5
San Francisco, Calif.		[1] 8	3	4	3	4
San Juan, P.R.			4	4	3	2
Seattle, Wash.		9	8	6	7	7
Spokane, Wash.		10	6	6	7	7
St. Louis, Mo.			[2] 7	8	7	8
Syracuse, N.Y.		7	7	7	6	6
Tampa, Fla.			5	6	5	5
Trenton, N.J.		[1] 10	7	8	7	9
Washington, D.C.			8	8	6	6
Wichita, Kans.		7	6	5	5	7
Wilmington, Del.		[1] 10	8	8	7	6
Network average		9	8	8	6	7

[1] Average based on one month.
[2] Average based on two months.
[3] Sample lost.

TABLE 8.—SUMMARY OF RESULTS, CESIUM-137 DETERMINATIONS, PROCESSED MILK AREA SAMPLING STATIONS, 1960–1961

[Average concentrations in $\mu\mu c$/liter]

Area	1960				1961	
	First quarter	Second quarter	Third quarter	Fourth quarter	First quarter	March
Albuquerque, N.Mex.				5	<5	<5
Atlanta, Ga.			[2] <5	<5	5	<5
Austin, Tex.		[1] 20	<5	[2] <5	<5	<5
Baltimore, Md.			[2] <5	<5	5	10
Boston, Mass.		[1] 30	15	<5	10	10
Buffalo, N.Y.		[1] 10	<5	<5	[2] <5	(3)
Burlington, Vt.		15	5	<5	5	10
Charleston, S.C.			[2] 10	<5	5	<5
Charleston, W.Va.		<5	<5	<5	<5	<5
Charlotte, N.C.		[1] 20	<5	<5	<5	<5
Chattanooga, Tenn.			<5	<5	<5	<5
Chicago, Ill.			<5	<5	[2] <5	(3)
Cincinnati, Ohio			[2] <5	<5	<5	<5
Cleveland, Ohio			<5	<5	<5	<5
Dallas, Tex.		[1] <5	<5	<5	<5	<5
Denver, Colo.				10	5	10
Des Moines, Iowa			[1] 20	[2] 15	<5	<5
Detroit, Mich.			<5	<5	<5	<5
Grand Rapids, Mich.			<5	10	<5	<5
Hartford, Conn.		20	10	<5	10	10
Helena, Mont.			[1] 25	5	<5	<5
Honolulu, Hawaii		[1] 40	[1] 40	10	<5	<5
Idaho Falls, Idaho		[1] 40		10	<5	<5
Indianapolis, Ind.			<5	<5	<5	<5
Jackson, Miss.			[2] <5	<5	<5	<5
Kansas City, Mo.				10	<5	<5
Laramie, Wyo.				10	<5	<5
Las Vegas, Nev.				<5	<5	<5
Little Rock, Ark.			[2] <5	[2] <5	5	10
Louisville, Ky.		<5	5	<5	<5	<5
Manchester, N.H.		45	25	15	15	20
Memphis, Tenn.			[1] <5	<5	<5	<5
Milwaukee, Wis.			<5	<5	<5	<5
Minneapolis, Minn.				<5	<5	<5
New Orleans, La.			5	<5	10	15
New York, N.Y.		[1] 20	5	<5	[2] 5	10
Norfolk, Va.			<5	<5	[2] <5	(3)
Oklahoma City, Okla.			<5	<5	<5	<5
Omaha, Nebr.				5	5	<5
Palmer, Alaska			[1] 30	<5	<5	<5
Philadelphia, Pa.		[1] 30	5	<5	<5	<5
Phoenix, Ariz.			[1] 15	15	<5	<5
Pittsburgh, Pa.		15	5	<5	<5	5
Portland, Me.		[1] 40	20	5	[2] 10	(3)
Portland, Oreg.			70	20	10	10
Providence, R.I.		[1] 20	10	<5	10	10
Sacramento, Calif.				<5	<5	<5
Salt Lake City, Utah				5	5	5
San Francisco, Calif.			[1] 20	5	<5	<5
San Juan, P.R.			<5	<5	<5	<5
Seattle, Wash.			[1] 60	20	10	<5
Spokane, Wash.				20	5	<5
St. Louis, Mo.				35	10	10
Syracuse, N.Y.		15	10	<5	<5	<5
Tampa, Fla.			[2] 85	70	35	40
Trenton, N.J.		[1] 20	<5	<5	<5	<5
Washington, D.C.			5	<5	<5	<5
Wichita, Kans.				<5	<5	<5
Wilmington, Del.		[1] 40	<5	<5	<5	<5
Network average			10	5	<5	5

[1] Average based on one month.
[2] Average based on two months.
[3] Sample lost.

TABLE 9.—SUMMARY OF RESULTS, CALCIUM DETERMINATIONS, PROCESSED MILK AREA SAMPLING STATIONS, 1960–1961

[Average concentrations in $\mu\mu c$/liter]

Area	1960				1961	
	First quarter	Second quarter	Third quarter	Fourth quarter	First quarter	March
Albuquerque, N.Mex.	[1] 1.20	1.12	1.04	1.06	1.05	0.99
Atlanta, Ga.			[2] 1.24	1.24	1.21	1.16
Austin, Tex.		[1] 1.16	1.09	[2] 1.27	1.26	1.28
Baltimore, Md.			[2] 1.08	1.22	1.28	1.22
Boston, Mass.		[1] 1.31	1.13	1.22	1.27	1.29
Buffalo, N.Y.		[1] 1.41	1.12	1.16	[2] 1.18	([3])
Burlington, Vt.		1.22	1.15	1.22	1.23	1.22
Charleston, S.C.			[2] 1.22	1.30	1.35	1.38
Charleston, W.Va.		1.21	[2] 1.08	1.23	1.21	1.19
Charlotte, N.C.		[1] 1.07	1.23	1.29	1.28	1.26
Chattanooga, Tenn.			[1] 1.27	1.31	1.33	1.34
Chicago, Ill.			1.09	1.20	[2] 1.16	([3])
Cincinnati, Ohio.			[2] 1.15	1.20	1.24	1.24
Cleveland, Ohio.			1.09	1.23	1.21	1.24
Dallas, Texas.		[1] 1.35	1.19	1.20	1.29	1.28
Denver, Colo.	[1] 1.10	1.18	1.02	1.08	1.03	1.03
Des Moines, Iowa.		[1] 1.10	1.00	[2] 1.08	1.07	1.10
Detroit, Mich.			1.13	1.20	1.19	1.20
Grand Rapids, Mich.			[2] 1.20	1.28	1.24	1.26
Hartford, Conn.		1.21	1.10	1.28	1.19	1.21
Helena, Mont.		[1] 1.00	1.10	1.09	1.04	1.07
Honolulu, Hawaii.		1.07	1.04	1.09	1.05	0.97
Idaho Falls, Idaho.	[1] 1.10	1.03	1.05	1.11	1.05	1.00
Indianapolis, Ind.			1.06	1.25	1.26	1.28
Jackson, Miss.			[2] 1.25	1.35	1.37	1.34
Kansas City, Mo.		1.10	1.05	1.05	1.05	0.99
Laramie, Wyo.		1.10	1.01	1.07	1.06	1.02
Las Vegas, Nev.	[1] 1.10	[2] 1.15	0.99	1.02	1.03	0.97
Little Rock, Ark.			[2] 1.20	[2] 1.21	1.27	1.22
Louisville, Ky.		1.24	1.11	1.23	1.21	1.22
Manchester, N.H.		1.31	1.13	1.23	1.21	1.26
Memphis, Tenn.			[1] 1.22	1.27	1.30	1.26
Milwaukee, Wis.			1.11	1.19	1.23	1.28
Minneapolis, Minn.			1.00	1.08	1.00	1.01
New Orleans, La.			1.23	1.28	1.31	1.34
New York, N.Y.		[1] 1.24	1.06	1.19	[2] 1.18	1.22
Norfolk, Va.			1.16	1.24	[2] 1.20	([3])
Oklahoma City, Okla.			1.15	1.20	1.29	1.32
Omaha, Nebr.			[2] 1.00	1.06	1.05	0.98
Palmer, Alaska.	[1] 1.10	1.10	1.09	1.07	1.08	1.00
Philadelphia, Pa.		[1] 1.25	1.10	1.22	1.27	1.29
Phoenix, Ariz.			1.00	1.04	1.09	1.01
Pittsburgh, Pa.		1.24	[2] 1.17	1.22	1.24	1.26
Portland, Me.		[1] 1.22	1.09	1.16	[2] 1.20	([3])
Portland, Oreg.		1.10	1.09	1.18	1.11	1.06
Providence, R.I.		[1] 1.29	1.10	1.29	1.26	1.30
Sacramento, Calif.			[2] 1.05	1.07	1.12	1.06
Salt Lake City, Utah.	[1] 1.20	1.10	1.08	1.07	1.05	1.04
San Francisco, Calif.		[1] 1.10	1.07	1.16	1.05	0.99
San Juan, P.R.			1.12	1.19	1.15	1.23
Seattle, Wash.		1.10	1.07	1.10	1.09	1.08
Spokane, Wash.		1.05	1.05	1.15	1.12	1.18
St. Louis, Mo.			[2] 1.02	1.07	1.01	0.98
Syracuse, N.Y.		1.28	1.16	1.23	1.22	1.25
Tampa, Fla.			[2] 1.24	1.27	1.26	1.22
Trenton, N.J.		[1] 1.26	1.12	1.31	1.24	1.28
Washington, D.C.			1.13	1.21	1.23	1.30
Wichita, Kans.		1.13	1.03	1.09	1.05	1.00
Wilmington, Del.		[1] 1.26	1.18	1.22	1.22	1.26
Network average		1.15	1.11	1.19	1.18	1.17

[1] Average based on one month.
[2] Average based on two months.
[3] Sample lost.

Strontium-90 In Canadian Dried Milk Products

The following table presents the results of strontium-90 determinations in Canadian dried milk samples for the months of October, November, and December, 1960. This table was included in the "Quarterly Report of the Radioactive Fallout Study Program," dated April 1961, published by the Radiation Protection Division of the Department of National Health and Welfare, Ottawa, Canada. Figure 1 illustrates the sampling locations.

Data for the previous months in 1960 were published in *Radiological Health Data*, Volume I, Numbers 6 and 9, and Volume II, No. 4.

FIGURE 1.—MILK SAMPLING STATIONS IN CANADA

TABLE 1.—STRONTIUM-90 CONTENT OF CANADIAN DRIED MILK POWDER SAMPLES, FOURTH QUARTER 1960

[Concentrations in $\mu\mu$c/gm calcium]

Station	October	November	December	Station	October	November	December
Calgary	13.2	8.0	15.6	Moncton [1,2]	11.4	11.6	9.6
Charlottetown	[3] NS	NS	NS	Ottawa [1]	4.7	6.9	4.9
Chicoutimi	10.4	13.8	12.4	Saskatoon [2]	5.5	7.1	9.6
E. Florenceville	11.4	11.7	NS	Sussex	9.3	10.7	10.1
Edmonton [1]	8.7	7.3	10.5	Vancouver [1]	10.4	10.5	12.7
Granby [1]	12.4	21.2	8.6	Walkerton	3.9	5.6	4.7
La Durantye	14.0	13.0	14.0	Winnipeg [2]	6.3	6.6	7.2
London [1]	3.6	4.2	4.7				
Megantic	8.3	12.6	8.1	Average	8.9	10.0	9.5

[1] Natural strontium determinations made for these stations. All other stations were corrected for natural strontium using an average factor of 1.06.
[2] Buttermilk sample. All other samples are skim milk.
[3] NS = No milk powder manufactured for the month.
Samples collected by inspectors of the Marketing Division, Department of Agriculture.

SECTION IV. — WATER

National Water Quality Network

Division of Water Supply and Pollution Control
Public Health Service

The National Water Quality Network was established under the provision of Section 4(c) of Public Law 660, which states ". . . The Surgeon General shall . . . collect and disseminate basic data . . . (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and local health agencies, was started in October 1957. At present, there are 86 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial, and other uses. Some of these stations are on interstate, coastal, and International Boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately, a total of 250 to 300 stations will be in operation. A few of the more recently established stations have not begun to report radioactivity.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some, continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The levels of radioactivity associated with dissolved solids provide a rough measure of levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally-occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the presence of the same nuclides. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River.

While beta determinations for the first two years of the Network operation have been conducted on each sample weekly, the alpha determinations are reported generally on a composite sample of more than one week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two weekly samples. The alpha data will be reported on three-month composite samples, with ¼ of the stations being covered each month.

All the data reported in table 1 represent the average of all information available for the month indicated.

Strontium-90 data reported are the results of determinations on composite samples for a three-month period ending in the month shown.

Additional information and data may be obtained from the following sources:

1. "National Water Quality Network Annual Compilation of Data," PHS Publication. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price $1.50.
2. "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, at the Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 167–169.
3. Setter, L. R., Regnier, J. E., and Diephaus, A. "Radioactivity of Surface waters in the United States," Jour. AWWA *51*, 1377 (1959).
4. Straub, C. P., Setter, L. R., Goldin S., and Hallbach, P. F., "Strontium-90 in Surface Waters," Jour. AWWA *52*, 756 (1960).
5. Setter, L. R., and Baker, S. L., "Radioactivity of Surface Waters in the United States," *Radiological Health Data*, Volume I, No. 7 (1960).

FIGURE 1.—NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS

As of June 1, 1961

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Concentrations in μμc/liter]

Station	Quarter ending December 31, 1960	February 1961					
	Strontium-90	Beta activity			Alpha activity		
		Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa	—	0	0	0	0	0	0
Animas River: Cedar Hill, N. Mex	—	24	20	44	10	18	28
Apalachicola River: Chattahoochie, Fla	—	0	0	0	—	—	—
Arkansas River: Ponca City, Okla	—	0	0	0	8	4	12
Chattahoochie River:							
Atlanta, Ga	0.3	2	5	7	0	0	0
Columbus, Ga	—	3	0	3	0	0	0
Colorado River:							
Loma, Colo	—	0	0	0	4	5	9
Page, Ariz	0.4	271	24	295	54	10	64
Hoover Dam, Ariz.-Nev	—	0	4	4	0	5	5
Parker Dam, Ariz.-Calif	1.2	0	6	6	0	6	6
Yuma, Ariz	—	0	0	0	<1	4	5
Columbia River:							
Wenatchee, Wash	—	0	0	0	0	0	0
Pasco, Wash	—	105	593	698	0	0	0
Bonneville Dam, Oreg	0.5	86	139	225	—	—	—
Clatskanie, Oreg	—	23	48	71	0	0	0
Delaware River: Martin's Creek, Pa	—	0	0	0	0	0	0
Escambia River:							
Century, Fla	[1]	0	0	0	0	0	0
Great Lakes:							
Gary, Ind	—	0	1	1	0	0	0
Duluth, Minn	—	0	0	0	0	0	0
Milwaukee, Wis	0.2	0	0	0	0	0	0
Hudson River: Poughkeepsie, N.Y	0.4	0	0	0	1	0	1
Illinois River: Peoria, Ill	0.5	0	0	0	0	1	1
Kanawha River: Winfield Dam, W.Va	—	2	0	2	3	0	3
Klamath River: Copco, Oreg	—	0	0	0	<1	0	<1
Little Miami River: Cincinnati, O	[1]	1	<1	1	1	<1	1
Mississippi River							
West Memphis, Ark	1.0	0	5	5	2	1	3
Delta, La	—	0	7	7	2	0	2
New Orleans, La	—	2	6	8	3	1	4
Missouri River:							
Williston, N.D	—	0	2	2	1	5	6
Bismarck, N.D	—	2	1	3	0	2	2
St. Joseph, Mo	0.5	0	2	2	6	4	10
St. Louis, Mo	—	0	2	2	21	2	23
Ohio River:							
East Liverpool, O	—	0	0	0	0	0	0
Wheeling, W. Va	0.6	—	—	—	—	—	—
Cincinnati, Ohio	—	2	0	2	2	0	2
Cairo, Ill	—	4	0	4	1	0	1
Red River, North: Grand Forks, N.D	—	<1	5	5	0	0	0
Red River, South: Denison, Tex	0.7	0	0	0	1	1	2
Rio Grande River:							
Alamosa, Colo	—	0	2	2	0	<1	<1
El Paso, Tex	—	0	0	0	<1	<1	1
Laredo, Tex	—	0	0	0	1	1	2
Brownsville, Tex	—	0	0	0	—	—	—
Sabine River: Ruliff, Tex	—	4	0	4	2	0	2
St. Clair River: Port Huron, Mich	—	0	0	0	0	0	0
St. Lawrence River: Massena, N.Y	0.6	4	4	8	0	<1	<1
Schuylkill River: Philadelphia, Pa	[1]	0	0	0	3	0	?
Savannah River:							
Port Wentworth, Ga	0.5	2	10	12	1	0	1
North Augusta, S.C	—	0	0	0	0	0	0
Snake River: Wawawai, Wash	—	0	0	0	0	1	1
Susquehanna River:							
Sayre, Pa	—	0	0	0	0	0	0
Conowingo, Md	0.4	0	<1	<1	<1	<1	1
Tennessee River:							
Chattanooga, Tenn	0.9	9	55	64	—	—	—
Bridgeport, Ala	—	4	111	115	0	<1	<1
Yellowstone River: Sidney, Mont	—	1	0	1	0	5	5

[1] Insufficient sample for analysis.

Analyses of Cistern Water

Division of Radiological Health, Public Health Service, and U.S. Coast Guard

Monthly samples of several U.S. Coast Guard roof-collected rain water cistern supplies are routinely analyzed for beta activity by the Robert A. Taft Sanitary Engineering Center, Public Health Service, Cincinnati, Ohio. Some samples are composited each three months and further analyzed for strontium-90 activity. Additional data concerning this investigation appears in the "Statement on New Data on Uptake in Milk, Food and Human Bone," by C. P. Straub, submitted to the Joint Committee Hearings on Fallout from Nuclear Weapons, May 1959, Volume II, page 990.

A few of the results presented in table 1 have appeared previously in *Radiological Health Data*, Volume I, Number 3.

TABLE 1.—U.S. COAST GUARD CISTERN WATER SAMPLES, FOURTH QUARTER 1959

Location	Date collected	Solids (ppm)		Beta activity (μμc/liter)	
		Suspended	Dissolved	Dissolved	Total
Cape Flattery, Wash.	November 6	20	46	18	49
Cape Hatteras, N.C.	October 28	8	36	14	28
	November 30	14	44	25	27
	December 18	20	22	6	7
Catanduanes, Panay Island, P.I.	October 15	12	78	4	4
Cobb Island, Md.	October 30	2	53	36	47
	November 30	17	47	20	29
Cocos Island, Marianas, Guam	October 19	15	101	20	24
Cuckolds, Maine	October 28	21	71	15	15
	December 5	13	260	0	22
	December 28	10	181	12	12
French Frigate, Shoals, Hawaii	October 15	21	456	51	72
Grand Island, La.	November 4	16	60	4	4
	December 16[1]	38	170	9	9
Iwo Jima	October 26	13	51	7	7
Kwajalein, Marshall Island	October 15	9	48	10	19
Metomkin Bay, Va.	October 26	14	32	25	33
	December 1	20	81	60	63
	December 21	7	65	34	41
Moose Peak, Maine	October 31	18	322	38	43
	December 2	16	165	15	16
	December 29	12	191	11	11
Patos Island, Wash.	November 1	29	73	8	9
	December 10	10	65	4	4
Port O'Conner, Tex.	November 20	16	72	16	25
	December 21	17	78	17	22
Swansboro, N.C.	October 27	14	96	39	47
	December 3	10	74	33	37
	December 28	11	64	43	60
Wake Island	October 8	16	224	24	27

[1] 3,200 gallons purchased water added.

TABLE 2.—U.S. COAST GUARD CISTERN WATER SAMPLES, FIRST QUARTER, 1960

Location	Date collected	Solids (ppm)		Beta activity (μμc/liter)	
		Suspended	Dissolved	Dissolved	Total
Cape Flattery, Wash.	January 1	10	72	18	21
	February 1	8	89	15	15
	March 4	16	132	26	26
Cape Hatteras, N.C.	January 20	28	30	9	9
	February 29	11	42	25	37
	March 21	18	33	32	40
Cobb Island, Md.	February 2	13	70	31	40
Cuckolds, Maine	January 22[1]	26	75	5	5
	February 25	19	268	4	4
Grand Island, La.	January 6	15	140	7	7
	February 1[2]	19	136	4	5
	March 21	16	66	9	11
Metomkin Bay, Va.	January 20	29	122	36	45
	March 18	2	139	50	80
Moose Peak, Maine	January 27	13	143	[3] ND	12
Patos Island, Wash.	January 28	20	65	[3] ND	[3] ND
	February 29	8	61	[3] ND	[3] ND
Port O'Conner, Tex.	January 20	20	172	16	22
Swansboro, N.C.	January	23	109	23	23
	February 23	5	263	6	23

[1] 2,200 gallons fron Portland, Maine added.
[2] 6.400 gallons purhased water added.
[3] ND = Non-detetable.

TABLE 3.—U.S. COAST GUARD CISTERN WATER SAMPLES, STRONTIUM-90 AND GROSS BETA DETERMINATIONS, SECOND QUARTER, 1960

[Concentrations in $\mu\mu c$/liter]

Location	Gross beta activity			Sr^{90}
	Dissolved [1]	Total [1]	Total [2]	
Atlantic Coastal States				
Cape Hatteras, N.C.	11.9	17.8	28.1	1.6
Cobb Island, Md.	30.4	45.1	70.8	3.5
Cuckolds, Maine [3]			12.0	1.2
Metomkin Bay, Va.	35.0	49.2	78.6	4.6
Moose Peak, Maine	14.2	18.0	28.8	1.9
Swansboro, N.C.	26.5	33.1	52.4	2.3
Average, excluding Cuckolds, Maine			51.7	2.8
Gulf States				
Grand Island, La. [3]	13.4	14.7	23.4	1.3
Houston, Tex., Rain				11.5
Port O'Conner, Tex.	13.6	17.3	26.6	3.0
Mid-West				
Montgomery, Ohio	14.9	22.0	33.8	2.5
Pacific Coastal States				
Cape Flattery, Wash.	22.1	49.2	75.6	2.1
Patos Island, [3] Wash.	0.05	0.05		0.6
U.S. Average, excluding Cuckolds, Grand Island and Patos Island			49.3	2.7

[1] Average of observed values obtained usually within ten days after collection.

[2] Average of observed values extrapolated to one-year-old mixed products assuming detonation on November 3, 1958.

[3] Records show that substantial volumes of non-rain potable drinking water was added to the cistern.

SECTION V. — OTHER DATA

External Gamma Activity

Radiation Surveillance Network, Public Health Service

Portable survey instruments are available at stations of the Radiation Surveillance Network for recording levels of external gamma radiation. Measurements are made daily approximately three feet above the ground. These readings are not precise but are sufficiently accurate to illustrate any significant variations above background. The differences among the values shown in the following table are within the variance anticipated due to differences in normal background and instrument response characteristics.

TABLE 1.—EXTERNAL GAMMA ACTIVITY, MARCH 1961

Station location	Average (mr/hr)	Station location	Average (mr/hr)	Station location	Average (mr/hr)
Anchorage, Alaska	0.01	Indianapolis, Ind	0.01	Oklahoma City, Okla	0.01
Fairbanks, Alaska	[1]	Iowa City, Iowa	0.01	Ponca City, Okla	0.04
Juneau, Alaska	0.01	Topeka, Kan	0.02	Portland, Oreg	0.02
Phoenix, Ariz	0.01	New Orleans, La	0.01	Harrisburg, Pa	0.01
Little Rock, Ark	0.01	Baltimore, Md	0.02	Providence, R.I	0.02
Berkeley, Calif	0.01	Lawrence, Mass	0.02	Columbia, S.C	0.02
Los Angeles, Calif	0.01	Lansing, Mich	0.02	Cincinnati, Ohio	[1]
Denver, Colo	0.02	Minneapolis, Minn	0.01	Pierre, S.Dak	0.02
Hartford, Conn	0.02	Pascagoula, Miss	[1]	Austin, Tex	0.01
District of Columbia	0.02	Jefferson City, Mo	0.01	El Paso, Tex	0.02
Jacksonville, Fla	0.02	Helena, Mont	0.03	Salt Lake City, Utah	0.02
Atlanta, Ga	[1]	Trenton, N.J	0.02	Richmond, Va	0.01
Honolulu, Hawaii	0.03	Santa Fe, N.M	0.04	Seattle, Wash	0.02
Boise, Idaho	0.01	Albany, N.Y	0.02	Madison, Wis	0.01
Springfield, Ill	0.01	Gastonia, N.C	0.02	Cheyenne, Wyo	0.02

[1] No Data Received.

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The U.S. Atomic Energy Commission is providing data on environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis. The data are from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Radiological Health Data, Volume I, Numbers 8 and 9, and Volume II, Numbers 1 through 7 contain summaries for 17 installations. Summaries follow for the Connecticut Aircraft Nuclear Engine Laboratory, Mound Laboratory, Portsmouth Gaseous Diffusion Plant, and the Savannah River Plant for the fourth quarter of 1960.

Connecticut Aircraft Nuclear Engine Laboratory

Pratt and Whitney Aircraft,
Division of United Aircraft Corporation
Middletown, Connecticut

—Issued December 1960 and April 1961

Environmental levels of radioactivity at the Connecticut Aircraft Nuclear Engine Laboratory (CANEL) for 1959 and the first and second quarters of 1960 were reported in *Radiological Health Data*, Volume I, No. 8 and Volume II, No. 2. The following report presents a summary of the data for the third quarter and an annual summary for 1960. Due to a change in defense planning the Government has canceled the development of a nuclear aircraft engine. Therefore, it is contemplated that subsequent reports by CANEL will not be issued.

The environmental monitoring program at CANEL consists of collecting and analyzing samples of drinking water, Connecticut River water, process water, domestic sewer water, precipitation, and air.

The CANEL facility has three retention tank vaults which are designed to collect laboratory wastes which might be radioactive. These tanks are sampled and analyzed before their contents are discharged to the Connecticut River. All samples are analyzed for gross alpha and beta activity.

Air Monitoring

One-hundred and eighty air samples were collected at a central location (weather station) during 1960. All samples were collected with a high volume air sampler, and each sample was allowed to decay at least 7 days before any gross alpha and beta analyses were made. Twenty-eight air samples were collected from random locations either on or in the vicinity of CANEL during this period. Table 1 presents the data for the air monitoring at the weather station and other randomly selected sites.

TABLE 1.—ATMOSPHERIC GROSS ALPHA AND BETA CONCENTRATIONS, 1960

[Average concentrations in $\mu\mu c/m^3$]

Location	Third quarter			Annual summary		
	Number of samples	Alpha	Beta	Number of samples	Alpha	Beta
Weather station	52	0.001	0.237	180	0.002	0.170
On and around CANEL site	10	0.001	0.132	28	0.002	0.224

The average alpha concentration shown above for the calendar year 1960 is equal to 5 percent of the MPC for unidentified alpha emitters for populations in the vicinity of a controlled area. Similarly, the average beta concentration is equal to 2 percent of its MPC. It should be noted that, on the average, both the alpha and beta concentrations are highly variable and the averages are not statistically significant.

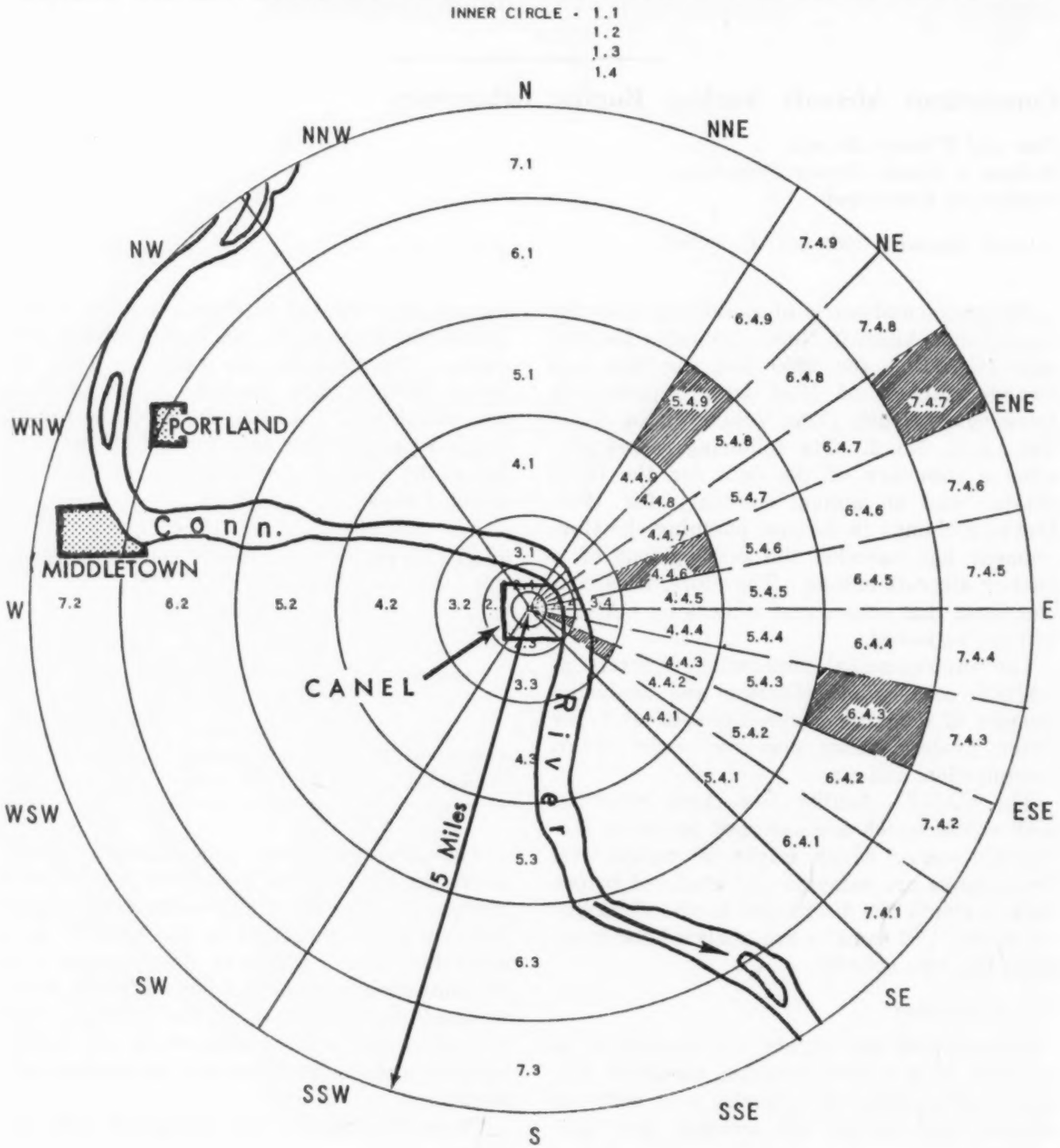
These air samples were compared with air

samples collected at random locations around the CANEL area in the preoperation period of 1957 and 1958. At a 95 percent significance level there was no significant difference in alpha concentration, but there was a significant decrease in beta concentration. There was also a significant decrease in beta concentration when 1960 samples were compared with 1959 samples. As in the case of fallout samples, it is possible that a significant decrease in activity may be noted for some time due to the time it takes for fission products to be eliminated from the atmosphere, assuming no new fission products are added to the atmosphere.

Water Monitoring

Environmental water samples were collected at 20 locations on and in the vicinity of the

FIGURE 1.—SAMPLING LOCATIONS, CONNECTICUT AIRCRAFT NUCLEAR ENGINE LABORATORY



CANEL site. Water samples were collected in each sector of an annulus, numbers 3.1 through 7.4 as shown in figure 1. The center of this diagram is near the center of the CANEL site, and the outer circle is at a distance of 5 miles from the center. Gross alpha and beta analyses are made on the soluble and insoluble portions of monthly samples from each location. The results from the third quarter and the yearly summary are presented in table 2.

TABLE 2.—GROSS RADIOACTIVITY IN ENVIRONMENTAL WATER, 1960

[Average concentrations in μμc/liter]

Activity	Third quarter			Annual summary		
	Number of samples	Soluble	Insoluble	Number of samples	Soluble	Insoluble
Alpha	60	0.17	0.15	240	0.25	0.44
Beta	60	7.61	5.88	240	5.28	4.27

All water samples were statistically analyzed using three variables of classification, i.e., date, distance, and direction. Significant effects have appeared for these variables and/or their combinations. These significant effects initiated a review of CANEL operations and a study of meteorological conditions. No unusual incidents occurred which could reasonably be expected to cause these variations. Selected stacks, which have the highest probability of emitting radioactive materials, have been continuously monitored. There is no evidence to justify concern about the amount of material which may have been released from these stacks. Therefore, it has been concluded that the statistically significant effects noted above were caused by natural variations and were not caused by CANEL operations. Also, even though statistically significant effects have appeared, the average level of total gross activity is only 10 percent of the MPC for populations in the vicinity of a controlled radiation area.

The 1960 water samples were compared with water samples taken in the preoperational period (1957 and 1958) by means of the "t–test." There was a significant decrease in activity at the 95 percent significance level. There was also a significant decrease when samples collected in 1960 were compared with samples collected in 1959.

There is no apparent cause for this decrease that can be attributed to CANEL operations. Since the higher levels of activity in the base period and 1959 were not attributed to CANEL operations, it is concluded that the indicated decreases are due to a decrease in natural or man-made activity external to CANEL.

Samples of drinking water were collected from two wells in use on the CANEL site. Samples were collected once every 20 days. The well sampled on a given date was the one in use at that time. The data are shown in table 3.

TABLE 3.—GROSS ALPHA AND BETA CONCENTRATIONS IN WELL WATER, 1960

[Average concentrations in μμc/liter]

Activity	Third quarter			Annual summary		
	Number of samples	Soluble	Insoluble	Number of samples	Soluble	Insoluble
Alpha	4	0.28	0.14	16	0.38	0.20
Beta	4	3.36	7.67	16	3.20	6.40

The average total gross concentration of radioactivity in drinking water from the two wells for the calendar year was 10.2 μμc/liter. This is equivalent to 10.2 percent of the MPC for populations in the vicinity of a controlled area. The results for 1960 were significantly greater than the activity in the preoperational period. However, there was no significant difference at the 95 percent significance level when comparing 1960 results with 1959 results.

Samples of Connecticut River water were collected monthly at two locations throughout the year. One location is near the north boundary of the CANEL site (upstream of CANEL effluent), and the other is near the south boundary (downstream of CANEL effluent). A total of 26 samples was taken throughout the year. Table 4 presents the

TABLE 4.—GROSS ALPHA AND BETA CONCENTRATIONS IN CONNECTICUT RIVER WATER, 1960

[Average concentrations in μμc/liter]

Location	Activity	Third quarter		Annual summary	
		Soluble	Insoluble	Soluble	Insoluble
North boundary of site.	Alpha	0.18	0.95	0.15	0.49
	Beta	22.66	16.17	8.34	8.89
South boundary of site.	Alpha	0.14	0.79	0.24	0.42
	Beta	2.96	13.18	4.75	7.61

gross alpha and beta analyses on the soluble and insoluble portions of these samples.

The north samples were compared with south samples by means of the "t–test," and it was found that there was no statistically significant difference between the two locations.

The average total gross activity for the 26 samples taken during the years was 15.4 μμc/liter. This is equivalent to 15 percent of the MPC for off-site drinking water.

Precipitation

A total of 87 precipitation samples was collected at the weather station during 1960. The gross alpha and beta analyses made on the soluble and insoluble portions of the samples are presented in table 5.

TABLE 5.—GROSS ALPHA AND BETA IN PRECIPITATION, 1960

[Average concentrations in μμc/liter]

Activity	Third quarter		Annual summary	
	Soluble	Insoluble	Soluble	Insoluble
Alpha	0.40	0.11	0.91	0.35
Beta	27.30	8.03	34.80	10.33

The average total gross activity in precipitation was 46.4 μμc/liter for calendar year 1960. This would be equivalent to 46 percent of the MPC if this water were used as drinking water off-site. When compared to prior years these data show a significant decrease in activity. This decrease in activity in precipitation samples could conceivably go on for a few years. It may take several years for the activity in the atmosphere to be eliminated to such a concentration that significant decreases from year to year will not be detected.

Mound Laboratory

Monsanto Chemical Company
Miamisburg, Ohio

—Issued March 1961

Environmental levels of radioactivity at Mound Laboratory for 1959 and the first three quarters of 1960 were reported in *Radiological Health Data*, Volume I, Number 8, and Volume II, Number 3. The following report presents the data for the fourth quarter of 1960.

During the fourth quarter, no radioactive materials were used which might have contributed any measurable penetrating radiation such as gamma or hard beta to the environment. Polonium, plutonium and tritium are the possible air contaminants; polonium and tritium are possible river water contaminants.

Air Monitoring

Monitoring of the environmental air for tritium concentrations, by means of a continuous air monitor mounted in a panel truck, was performed routinely out to a distance of 20 miles from the laboratory. A total of 96 evaluations were made of 70 locations. The sampling locations for tritium are the same as the ones for polonium and plutonium. Figures 1 and 2 show the locations of sampling sites relative to Mound Laboratory. To date, the tritium concentrations in the environment have been immeasurable.

Monitoring for possible polonium and plutonium in the environment is accomplished by particulate air sampling equipment also mounted in the truck used for tritium air sampling. During this quarter, a total of 154 air samples were collected and analyzed. The long-lived gross alpha determination on collected filter paper samples was made only after sufficient time had elapsed after collection to permit the decay of the short-lived daughter products, randon and thoron. Filter paper samples are counted for alpha particle emission in a low background proportional counter.

Table 1 presents the gross alpha activity in air from polonium and plutonium.

FIGURE 1.—CLOSE-IN AIR SAMPLING LOCATIONS, MOUND LABORATORY

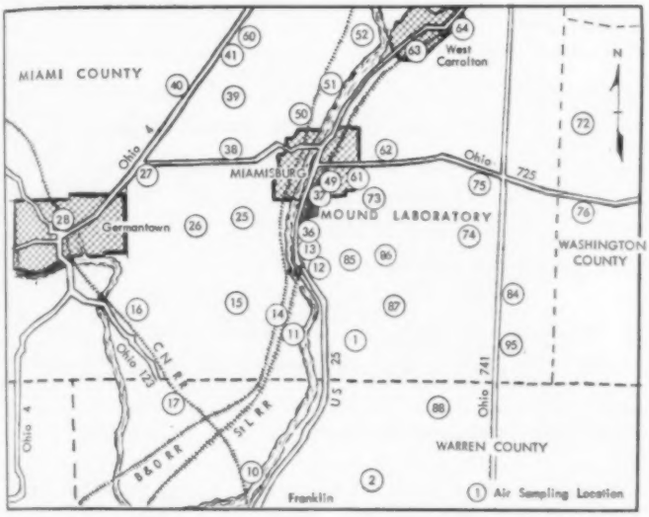
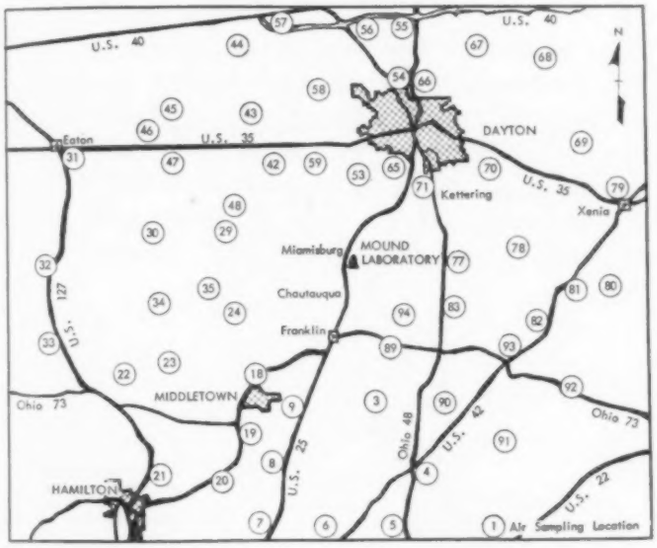


FIGURE 2.—DISTANT AIR SAMPLING LOCATIONS, MOUND LABORATORY



Alpha concentrations detected in environmental air were very low. A long counting time analysis was performed for each filter sample in order to obtain good counting precision. At the low concentrations detected, the isotopes of polonium and plutonium are not distinguishable from each other or from the natural background radioactivity in the air. If the gross alpha detected in the environment (see table 1) is compared to the maximum permissible concentration for polonium, and one assumes that all alpha activity detected is

TABLE 1.—GROSS ALPHA ACTIVITY IN AIR FROM POLONIUM AND PLUTONIUM, FOURTH QUARTER 1960

Location number (see fig. 1 and 2)	Number of samples	Average concentration ($\mu\mu c/m^3$)	Location number	Number of samples	Average concentration ($\mu\mu c/m^3$)
1	1	0.031			
2	1	0.020	48	1	0.029
3	1	0.019	61	5	0.030
4	1	0.051	62	5	0.025
5	1	0.041	63	5	0.019
6	1	0.041	64	5	0.011
7	1	0.009	65	5	0.014
8	1	0.032	66	5	0.018
9	1	0.028	67	5	0.012
10	1	ND	68	5	0.007
11	1	0.002	69	5	0.006
12	1	0.022	70	5	0.008
13	3	0.037	71	5	0.006
14	3	0.013	72	5	0.011
15	3	0.014	73	1	0.019
16	3	0.011	74	1	0.010
17	3	0.004	75	1	0.016
18	3	0.001	76	1	0.023
19	3	0.010	77	1	0.065
20	3	ND	78	1	0.032
21	3	0.015	79	1	0.020
22	3	0.005	80	1	0.004
23	3	0.011	81	1	0.015
24	3	0.014	82	1	0.014
37	1	0.042	83	1	0.007
38	1	0.071	84	1	0.048
39	1	0.065	85	2	0.003
40	1	0.078	86	2	0.019
41	1	0.122	87	2	0.002
42	1	0.046	88	2	0.029
43	1	0.079	89	2	0.064
44	1	0.028	90	2	0.002
45	1	0.315	91	2	0.028
46	1	0.025	92	2	0.011
47	1	0.028	93	2	ND
			94	2	0.001
			95	2	0.004
			Average	154	0.020

polonium, the average polonium concentration would be <0.1% MPC. The polonium effluent stack monitoring program for this quarter has shown that essentially no detectable polonium would be expected in the environment due to the operations at Mound Laboratory.

If the gross alpha detected in the environment is compared to the MPC for continuous exposure of populations in the vicinity of a controlled area, and it is assumed that all alpha activity detected is plutonium, the average plutonium concentration would be well within the MPC; however, it would be a significant 33 percent of the MPC. In order to determine the impact of Mound Laboratory plutonium work on the environment, it must be pointed out that the natural background concentration of alpha contamination in the air in Southwestern Ohio is in the range of, and frequently exceeds the very low MPC for plutonium. That is to say the normal long-lived gross alpha count in the environment is usually a very significant percent of, and frequently exceeds the permitted alpha count for plutonium if the total count were attributed to plutonium. The

impact of plutonium work at Mound Laboratory is also placed in proper focus by referring to plutonium stack monitoring data. During the fourth quarter of 1960, the average concentration of plutonium in air discharged from the stack was well within the permissible concentration for environmental air. For this reason, and the fact that the air is discharged to the environment from a 200 foot stack at a high velocity, we can say that the plutonium operations, as well as the polonium work, has contributed an insignificant amount of radioactivity to that normally present in the atmosphere.

Water Monitoring

Liquid radioactive waste materials from polonium work at the laboratory are processed in a special waste disposal plant designed to reduce radioactivity to a concentration level at which it may be discharged to the Great Miami River. Liquid waste from the plutonium work is small in volume. It is handled separately as a packaged waste and is not discharged to the river. Helium-3 being purified at Mound Laboratory yields small quantities of tritium. Liquid wastes from this work, also small in volume are treated separately (diluted with water when necessary) to assure that the radioactive content is within the maximum permissible concentration for discharge to the Great Miami River.

Samples are collected routinely each week from the laboratory effluent stream at the point of discharge and in the Great Miami River downstream to a distance of five miles. Once each quarter, river water samples are collected at various locations between Franklin, Ohio, and Elizabethtown, Ohio, where the Great Miami River enters the Ohio River. A weekly water sample is also collected from a drainage ditch which runs through the plant site. This ditch carries off all storm sewer water which eventually empties into the river. The treated liquid tritium waste is discharged into the storm sewers and the waste disposal plant effluent is discharged directly into the river via a closed sewer line. All of the samples collected from the river are analyzed to determine the polonium concentration. The drainage ditch sample and part of the river samples are analyzed for tritium concentration.

Data for the water monitoring in the Great Miami River are presented in table 2. Figure 3 shows the water sampling locations.

TABLE 2.—SUMMARY OF MONITORING FOR POLONIUM IN GREAT MIAMI RIVER, FOURTH QUARTER 1960

Sampling point number (see fig. 3)	Location	Number of samples	Average concentration ($\mu\mu c$/liter)
2	Mound Lab Effluent	11	15.60
3	250 yards downstream	11	0.98
4	Chautauqua Road Bridge	11	0.98
5	Chautauqua Dam	11	1.15
6	Franklin, Ohio	11	1.15
	Trenton, Ohio	1	ND [1]
	New Miami, Ohio	1	9.00
	7 miles north of New Baltimore, Ohio	1	1.80
	New Baltimore	1	ND
	Miamitown, Ohio	1	1.80
	5 miles north of Elizabethtown, Ohio	1	ND
	Elizabethtown, Ohio	1	ND

[1] ND = No detectable activity.

FIGURE 3.—WATER SAMPLING LOCATIONS IN GREAT MIAMI RIVER, MOUND LABORATORY

Conclusion

Concentrations of radioactivity in the environment at Mound Laboratory are well within the maximum permissible concentrations recommended for populations in the vicinity of controlled areas by the National Committee on Radiation Protection and Measurements.

Portsmouth Gaseous Diffusion Plant

Goodyear Atomic Corporation
Portsmouth, Ohio

—Issued February 1961

Environmental levels of radioactivity at the Portsmouth Gaseous Diffusion Plant for 1959 and first, second, and third quarters of 1960 were reported in *Radiological Health Data,* Volume I, No. 8 and Volume II, No. 3. The following report presents a summary of the data for the fourth quarter of 1960.

The Atomic Energy Commission facility in Pike County, Ohio, is a gaseous diffusion plant operated by the Goodyear Atomic Corporation. The chemical processing of gaseous uranium presents the ordinary problems of the chemical industry which uses toxic solvents and extracting solutions. Fumes and mists must be controlled and contaminants removed by filtering, scrubbing, or other practical means to prevent atmospheric contamination.

An extensive environmental survey is conducted on a monthly basis for radioactive materials that may be released from the plant to check the effectiveness of controls which are used. The program is also designed to determine the effect, if any, on the surrounding environment. The routine program consists of sampling water, air, and the general radiation background levels. Sampling locations are shown in figure 1.

Included in this report for the first time are values for the limit of sensitivity for each type of instrument, the limit of sensitivity being the minimum detectable concentration of radiation.

The values for the maximum permissible concentrations (MPC) for uranium and thorium in air and water are 1/10th of the MPC allowed for continuous occupational exposure as given in National Bureau of Standards Handbook 69, issued June 5, 1959.

The results show that in no instance have the average values for any single location exceeded the maximum permissible concentrations or exposure levels for the population outside of the plant's boundaries. In general, the average levels for the fourth quarter of 1960, compared to the third quarter of 1960, are almost identical, except in the airborne beta-gamma, which is approximately one-half of the third quarter value.

FIGURE 1.—SAMPLING LOCATIONS, PORTSMOUTH GASEOUS DIFFUSION PLANT

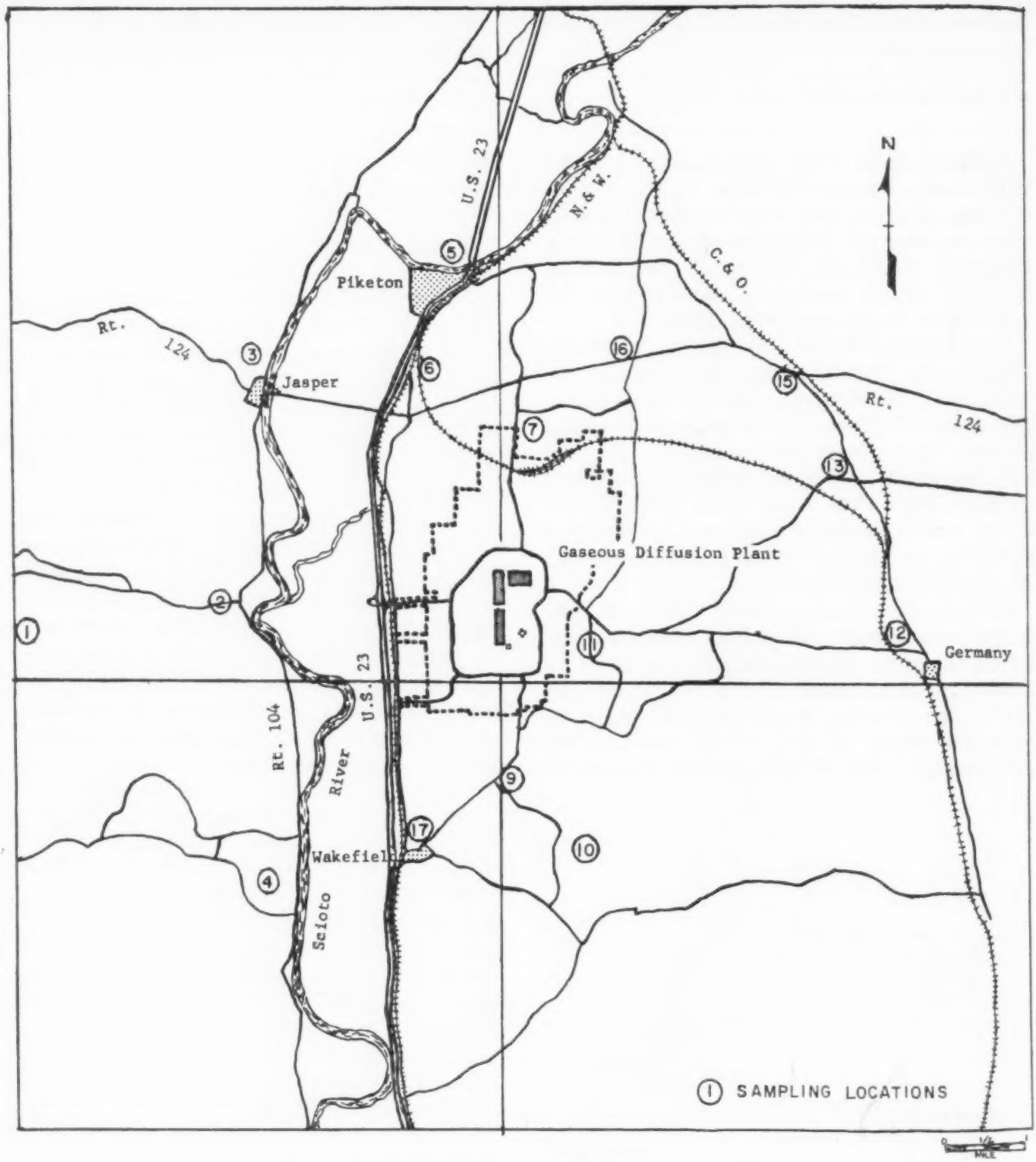


TABLE 1.—GROSS ALPHA AND BETA-GAMMA CONCENTRATIONS IN AIR SAMPLES, FOURTH QUARTER 1960

[Average concentrations in $\mu\mu c/m^3$]

Location		Alpha [1]	Percent MPC	Beta-gamma [2]	Percent MPC
Number (See fig. 1)	From plant				
1	5–6 mi W	0.1	5	0.3	0.03
2	2–3 mi W	0.1	5	0.6	0.06
3	4 mi NW	0.1	5	0.1	0.04
4	3–4 mi SW	0.1	5	<0.007	0.00
5	4–5 mi N	0.1	5	0.2	0.02
6	2–3 mi NNW	0.1	5	0.4	0.04
7	2–3 mi N	0.1	5	0.1	0.01
9	1–2 mi S	0.1	5	0.2	0.02
10	3–4 mi SSE	0.1	5	0.4	0.04
11	1 mi E	0.1	5	0.5	0.05
12	5 mi E	0.1	5	0.2	0.02
13	5–6 mi NE	0.1	5	0.1	0.01
15	5–6 mi NE	0.1	5	0.2	0.02
16	4 mi NE	0.1	5	0.4	0.04
17	2–3 mi SSW	0.1	5	0.2	0.02
Average		0.1	5	0.3	0.03

[1] Minimum limit of sensitivity = 0.01 $\mu\mu c/m^3$.
[2] Minimum limit of sensitivity = 0.007 $\mu\mu c/m^3$.

TABLE 2.—GROSS ALPHA AND BETA-GAMMA CONCENTRATIONS IN STREAM WATER SAMPLES, FOURTH QUARTER 1960

[Average concentrations in $\mu\mu c$/liter]

Stream and location from plant	Alpha [1]	Percent MPC	Beta-gamma [2]	Percent MPC
Scioto River 4–5 mi SSW	1.5	0.01	14.0	0.07
Salt Creek 2–3 mi SSW	14.0	0.07	14.0	0.07
Salt Creek 1 mi S	7.0	0.04	19.0	0.10
Big Beaver 3–4 mi ENE	2.5	0.01	14.0	0.07
Big Beaver 2–3 mi NNW	5.0	0.03	19.0	0.10
Scioto River 4–5 mi N	8.0	0.04	14.0	0.07
Little Beaver 2 mi NW	82.0	0.41	178.0	0.89
Little Beaver 1–2 mi NNW	38.0	0.20	50.0	0.25
Plant drainage 0 mi SW	2.5	0.02	37.0	0.19
Plant drainage 0 mi W	8.0	0.04	14.0	0.07
Plant drainage 0 mi NE	150.5	0.75	119.0	0.59
Little Beaver 1 mi E	2.0	0.01	19.0	0.10
Big Beaver 2 mi NW	166.0	0.83	137.0	0.69
Scioto River 1–2 mi W	3.0	0.07	14.0	0.07
Average	35.0	0.18	47.0	0.24

[1] Minimum limit of sensitivity = 0.5 $\mu\mu c$/liter.
[2] Minimum limit of sensitivity = 14.0 $\mu\mu c$/liter.

TABLE 3.—GROSS BETA-GAMMA BACKGROUND RADIATION LEVELS, FOURTH QUARTER 1960

[Millirads/hour]

Location		Average rate [1]
Number (see fig. 1)	From plant	
1	5–6 mi W	0.013
2	2–3 mi W	0.015
3	4 mi NW	0.012
4	3–4 mi SW	0.014
5	4–5 mi N	0.014
6	2–3 mi NNW	0.011
7	2–3 mi N	0.013
9	1–2 mi S	0.014
10	3–4 mi SSE	0.015
11	1 mi E	0.012
12	5 mi E	0.016
13	5–6 mi NE	0.014
15	5–6 mi NE	0.015
16	4 mi NE	0.012
17	2–3 m SSW	0.015
	Average	0.014

[1] Limit of sensitivity = $1 \times 10,^4$ mr/hr.

Savannah River Plant

E. I. du Pont de Nemours
Aiken, South Carolina

—Issued March 1961

Environmental levels of radioactivity at the Savannah River Plant for 1959 and the first, second, and third quarters of 1960 were reported in *Radiological Health Data*, Volume I, No. 9 and Volume II, No. 5. The following report presents a summary of the data for the fourth quarter of 1960.

The Savannah River Plant maintains a continuous monitoring program to determine the concentration of radioactive materials in a 1200 square mile area outside the plant perimeter. Included are parts of Aiken, Barnwell, and Allendale Counties in South Carolina, and Richmond, Burke, and Screven Counties in Georgia. The regional monitoring data obtained from the continuous surveillance of the Savannah River Plant environs during the fourth quarter of 1960 are useful both as measures of the effectiveness of plant controls and as evidence of strict adherence to the maximum permissible concentrations (MPC) as recommended by the National Committee on Radiation Protection.

A basic principle guiding plant operations is the total containment of radioactive wastes. Although some very low level gaseous and liquid wastes are discharged to the environment in controlled releases, the dispersal is adequate to insure that the concentration is well below the MPC.

Instruments which can detect traces of radioactive materials several orders of magnitude below that of hazard significance are used to determine radioactivity in the environs. Frequently, radioactivity could not be detected in environmental samples; in such instances, the minimum concentration that could be accurately detected by the analysis were used in determining the average concentrations. These values (sensitivity of analysis) are presented in the tables. In most cases, possible plant contributed radioactivity was either so small that it was less than that which exists naturally or it was obscured by the residual fallout from global nuclear weapons testing programs. Since radioactive materials contributed by each of these sources cannot be readily separated or interpreted in terms of origin, all are included in the reported concentrations.

Atmospheric Monitoring

Air and rain water samples were collected continuously at 13 monitoring stations, including five locations at the plant perimeter and 8 locations which circumscribe an area extending approximately 25 miles from the center of a plant. These stations, forming two concentric circles around the plant, are spaced in such a manner that a significant plant release of radioactivity to the air would be detected regardless of prevailing wind conditions (see figure 1). Additional air monitoring stations were operated at Savannah and Macon, Georgia, and at Columbia and Greenville, South Carolina. These four facilities (see figure 2), at locations so distant that the effect of Savannah River Plant operations is minimum (approximately 100 miles from the plant), serve as "reference points" for determining background levels of activity. This system permits a comprehensive surveillance of the atmospheric radioactivity and, in addition, makes it possible to differentiate between weapons testing fallout and plant releases.

The atmospheric concentrations of radioactivity are given in table 1. Radioactivity in rainwater is presented in table 2.

The continued decreased concentrations of airborne weapons tests debris have provided the opportunity to investigate more closely the effect of stack releases on concentrations of filterable beta radioactivity in environmental air samples. No relationship was observed since plant releases were so low that the small differences among the values shown are within the variances due to differences in normal

FIGURE 1.—SAMPLING LOCATIONS, SAVANNAH RIVER PLANT

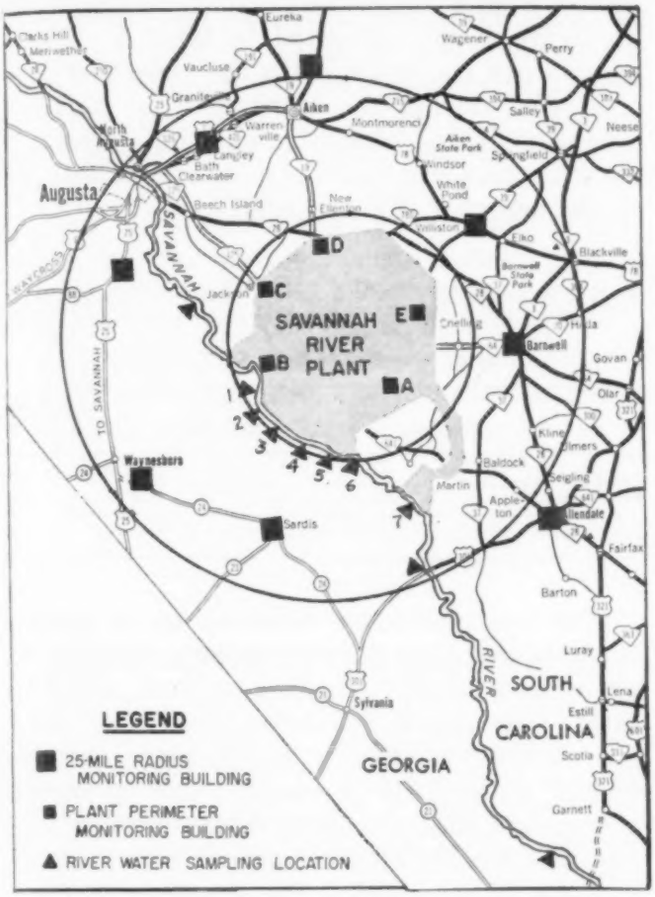


FIGURE 2.—DISTANT AIR MONITORING STATIONS, SAVANNAH RIVER PLANT

background and statistical variation of analysis.

No radioiodine was detected in air or rainwater samples. For this reason, individual radioiodine data are not recorded. The minimum detection limits of radioiodine in air and rainwater (assuming use as drinking water) are 0.02 percent and 1.1 percent of the respective 1/10th MPCs.

TABLE 1.—GROSS ALPHA AND BETA CONCENTRATIONS IN AIR, FOURTH QUARTER 1960

[Average concentrations in $\mu\mu c/m^3$]

location	Alpha	Nonvolatile beta
Plant perimeter	0.0010	0.07
25 mile radius	0.0008	0.05
100 mile radius	0.0011	0.04
Percent of 1/10 MPC at plant perimeter	2.5	0.007
Sensitivity of analysis	0.0004	0.008

TABLE 2.—GROSS ALPHA AND BETA CONCENTRATIONS IN RAINWATER, FOURTH QUARTER 1960

[Average concentrations in $\mu\mu c$/liter]

Location	Alpha	Nonvolatile beta
Plant perimeter	0.4	22
25 mile radius	0.4	
100 mile radius	No sample	No sample
Percent of 1/10 MPC at plant perimeter	4.0	0.7
Sensitivity of analysis	0.2	4

Water Monitoring

Communities in the vicinity of the Savannah River Plant obtained drinking water from deep wells or small surface streams. Results of public water samples collected locally from 14 surrounding towns are essentially the same as those observed prior to the startup of the Savannah River Plant in 1951. The average concentrations measured during the quarter are presented in the following table. The close agreement with results obtained prior to startup show no effect due to the plant operations.

TABLE 3.—GROSS ALPHA AND BETA CONCENTRATIONS IN PUBLIC WATER SUPPLIES, FOURTH QUARTER 1960

[Average concentrations in $\mu\mu c$/liter]

Analysis	Concentration	Percent of 1/10 MPC	Sensitivity of analysis
Alpha	1.2	12	0.2
Nonvolatile beta	6.0	0.2	4.0

For measurement of radioactivity in the river, water is continuously collected at ten river locations upstream from, adjacent to, and as far as 60 miles downstream from the

TABLE 4.—GROSS RADIOACTIVITY CONCENTRATIONS IN SAVANNAH RIVER WATER, FOURTH QUARTER 1960

[Average concentrations in μμc/liter]

Location	Alpha	Nonvolatile beta	Tritium	Strontium-90 [1]
3 miles upstream of plant	0.2	4	10,000	0.30
At plant perimeter	0.2	17	----------	----------
10 miles downstream of plant	<0.2	31	15,000	0.69
60 miles downstream of plant	0.3	25	13,000	----------
Percent of 1/10 MPC at 10 miles downstream	2.0	1.0	0.4	0.7
Sensitivity of analysis	0.2	4	4,000	0.1

[1] These averages include samples collected during September, October, and November 1960.

plant. Results of samples collected during the quarter are shown in table 4. During the first weeks of this report period, water was collected at seven other river sampling locations by taking a single weekly sample, or "grab sample," which reflected conditions only at the time when the sample was taken. In November, continuous samplers were installed at all the river sampling locations. Quarterly average concentrations of radioactivity in river water indicate that plant operations contribute small amounts of radioactivity to the river, but that the resulting concentrations are far below the MPC value and are of no health significance.

Environmental Gamma Radiation Levels

Environmental gamma radiation dose rates, obtained from continuous measurements, are taken in each of 13 monitoring stations. Plant operations had no measurable effect on the radiation levels in the public zone. The average dose rates at the perimeter locations and at the 25 mile radius locations (both 0.015 mr/hr) are essentially the same as the external gamma radiation levels recorded at all North American stations of the PHS Radiation Surveillance Network in July 1960.

Vegetation and Food Monitoring

Radioactive contamination of vegetation may result from direct deposition on exposed surfaces of the plant or from absorption of the radioactivity from the soil by the root system. Bermuda grass was selected for analysis because of its importance as a pasture grass for dairy herds and its availability during all seasons of the year.

Average concentrations of alpha and nonvolatile beta emitters found on vegetation collected from each of the circular routes shown in figure 1 are presented in table 5. These results are consistent with the concentrations measured during the third quarter of 1960. The radioiodine concentrations on vegetation samples were less than the minimum sensitivity of the analyses (0.6 μμc/gm).

TABLE 5.—GROSS ALPHA AND BETA CONCENTRATIONS IN GRASS SAMPLES, FOURTH QUARTER 1960

[Average concentrations in μμc/gm dry weight]

Location	Alpha	Nonvolatile beta
Plant boundary	0.14	16
25 mile radius	0.14	14
Sensitivity of analysis	0.10	2

Milk samples were collected on a weekly basis from three dairies (Aiken, North Augusta, and Langley, South Carolina) and two farms (Snelling and Talatha, South Carolina) and analyzed for tritium and radioiodine (primarily iodine-131) content. The quarterly average radioiodine concentration in milk samples was less than the minimum sensitivity of analysis (9 μμc/liter). The quarterly average tritium concentrations in milk were approximately 0.2% of the population MPC.

Strontium-90 content of locally produced milk is determined quarterly. In addition to the sampling points mentioned previously, milk from Wainsboro and Sylvania, Georgia, and New Ellenton, South Carolina, was sampled and analyzed. The concentrations of strontium-90 show no correlation with the distance from the plant and are attributed to fallout debris. The average concentration detected in milk samples from local dairies decreased from 14.5 μμc/liter to 11.6 μμc/liter during the fourth quarter of 1960.

The determination of radioactivity concentrations in algae is important because they are well known concentrators of specific radioactive materials and because of their relationship in the food chain of aquatic organisms. Indigenous algae, primarily green (*Vaucheria*) and blue-green (*Phormidium*), were collected weekly upstream from, adjacent to, and downstream from the plant. The average nonvola-

tile beta concentration observed in the river algae adjacent to the plant was 333 μμc/gm compared with the downstream average of 182 μμc/gm. Both of these concentrations show some correlation with the plant effluent entry into the river since the average concentrations of nonvolatile beta in algae upstream from the plant was 28 μμc/gm dry weight.

Fish (predominantly bream and catfish) were collected weekly above, adjacent to, and below the plant. The quarterly average nonvolatile beta concentrations measured in the edible portion (flesh) were 5 μμc/gm wet weight upstream from the plant, 6 μμc/gm at the plant boundary, and 5 μμc/gm at the 10 mile downstream sampling location. These concentrations show no plant contribution and are attributed to naturally occurring potassium-40.

General Conclusion

As previously established, concentrations of radioactivity in air show no relationship with plant releases. This conclusion was further demonstrated during the fourth quarter of 1960 by a comparison of atmospheric radioactivity at locations approximately 100 miles from the plant (some distance that the effect of plant operations is minimal) with that at the plant perimeter.

RADIATION EXPOSURE IN THE UNITED STATES

Radiation control programs should give equal consideration to minimize the exposure from all sources of radiation. Emphasis should not be placed on controlling exposure from radioisotopes to the exclusion of controlling exposure from machine-produced radiation. Furthermore, the establishment of an exposure limit should not be interpreted to encourage exposure up to this limit, but rather to keep exposure to a minimum consistent with the benefit received. The following article by Dr. Hanson Blatz discusses his philosophy on these points.

Some Reflections On Current Plans To Control Radiation Exposure In The United States

Hanson Blatz, Director
Office of Radiation Control
New York, New York

For many years, committees of distinguished scientists have been studying the overall effects of radiation exposure on humans and have been making recommendations. The committees include those of the National Academy of Sciences-National Research Council, the Federal Radiation Council, and the United Nations Scientific Committee on the Effects of Atomic Radiation. The report of the Federal Radiation Council states, "there is no necessity for setting the (permissible exposure) level (as high as 5 rems per year) because the doses actually received are generally much less at the present time." This represents the general philosophy of all the committees reporting.

The report of the National Academy of Sciences makes it quite clear, as do other reports, that the major fraction of man's exposure from man-made sources of radiation results from small doses of radiation received by large numbers of the population, rather than those doses being received by radiation workers. The reports of all committees seem to be most concerned with the control of the integrated dose to the gonads of the entire population and also with the statistical effects of small amounts of

radiation to large numbers of humans. The report of the Federal Radiation Council states that "every reasonable effort should be made to keep exposures as far below the recommended levels as practicable." It also states that "the degree of control effort should not depend solely on whether or not this guide is being exceeded." In the 1960 report of the National Academy of Sciences it is stated that "the average population exposure to man-made ionizing radiation, including medical radiation, should be not more than ten roentgens to the gonads per reproductive cycle; preferably, it should be less." The British Committee has a similar recommendation.

The records of the Atomic Energy Commission, its contractors and licensees, as well as those of other agencies keeping such records, show that the number of radiation overexposures is remarkably low considering the number of persons using radiation today. The number of radiation injuries is extremely small. This would appear to indicate that no great effort is needed to extend regulation in order to eliminate radiation injuries or keep exposure within the prescribed limits. X-ray injuries in recent years have been notably few in spite of little or no regulation.

A second group of committees has been equally active in enacting and recommending legislation to control radiation exposure. Presumably these committees have been guided by the recommendations of the scientific committees studying radiation effects and by recent experience. A review of the recommended legislation, however, indicates that it deals almost exclusively with the avoidance of the overexposure of radiation workers and individuals in the population. In most cases, there is no provision for the elimination of unnecessary radiation exposure where it is within the prescribed limits set for individuals. In the recent report of Subcommittee No. 10 of the National Committee on Radiation Protection (NCRP), the stated purpose of the recommended legislation is "to reduce, to an acceptable level, the risk that any person will be injured by radiation." In examining the details of the proposed rules, it is found that the regulatory agency is given ample authority to keep routine exposure within the general level of 5 rems per year for each radiation worker and 0.5 rems per year for the general population, but there is no authority to reduce unnecessary radiation exposure unless it exceeds these levels. This appears to be contrary to the needs expressed by the scientific committees who have studied sources of man-made radiation exposure and to recent experience. Neither is there any authority to require modification of facilities or procedures that are found to be likely to result in accidental overexposures.

In the case of the proposed State Radiation Control Act and Regulations prepared by the Council of State Governments, there seems to be a primary consideration for the control of atomic energy materials, whereas it is generally agreed by State and local regulatory agencies that a comprehensive radiation control program to cover all sources is more desirable.

As a result of inspecting many thousands of radiation installations in the City of New York, the most serious deficiency found, in terms of integrated gonadal dose in the population, is the fact that well over 50 percent of all X-ray machines used for taking chest X-rays unnecessarily expose the gonads of the patients to at least 100 times as much radiation as is actually necessary in order to take a satisfactory film. Similar conditions have been found in the medical and dental X-ray examinations of other parts of the body. An interesting fact is that in order to control such radiation exposure, very little effort or expense is involved on the part of those who are responsible for the use of the equipment, but the authority to require the necessary changes is important. The physicians and dentists involved have shown little reluctance to comply with the New York City regulation requiring filtration and the limitation of X-ray beam size, although they had not corrected the deficiencies voluntarily in spite of over twelve years of publicized recommendations by the NCRP, affiliated medical societies, and the Public Health Service. The propsed regulations of Subcommittee No. 10 of the NCRP do not permit an agency authority to correct such sources of unnecessary radiation to the population.

Similarly, experience shows that there seems to be considerable carelessness in the handling of medical and industrial radium sources, to

the extent that those individuals working with such sources undoubtedly receive considerably more radiation exposure than necessary, although they are not necessarily overexposed in terms of the prescribed limits.

Careful examination of many recently enacted State and local regulations shows a similar concern with avoiding overexposure and a lack of concern with the control of unnecessary exposure if it is within the prescribed limits. A few states, including Connecticut, Michigan, New York, and Pennsylvania, do have specific provisions for minimizing exposures, but the majority of states do not.

It is considered that there are over 5,000 chest X-ray examinations and probably 50,000 to 75,000 other X-ray examinations made in New York City every day, and about twenty times as many in the entire country. Thus, it would appear that a very large segment of the population dose could be substantially reduced if the codes being proposed and enacted included specific provisions for minimizing exposure.

In addition to preventing unnecessary exposure, radiation regulations should provide authority to guard against accidents which could result in serious overexposures to individuals or to populations. The regulations proposed by NCRP Subcommittee No. 10 do not appear to give either general or specific authority to review or correct hazardous conditions or procedures until there has been overexposure (except for the fire and earthquake provisions in the storage of radioactive materials and the possible spread of contamination, Sections 10 and 11).

Radium-226 In Bovine Bones and Teeth[1]

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Twenty-five bovine jawbones with teeth were collected from different States through the help of the U.S. Army Veterinary Service which furnished data on age, breed, diet, place and time of pasture. The samples were identified by numbers according to the time they were received, but for this study they are listed according to the point of origin. They are assigned to three groups corresponding to the western, central, and eastern regions of the United States.

Toothless portions of the jawbone and second or third premolars were used for the analyses unless these teeth were not available. The bones, ashed at 620°C, and the teeth at 1000°C, were dissolved in nitric acid and analyzed for radium-226 (Ra^{226}) content by the radon emanation technique (*1, 2*).

[1] Reported in *Semi Annual Report*, ANL-6199, January-June 1960, Argonne National Laboratory, Radiological Physics Division.

At least two determinations were made on each sample, and they agreed consistently to within ± 3.0 percent. Since the value of blank determinations was of the order of 0.01 μμg Ra^{226}, an insignificant amount compared with that in the total sample, no blank correction has been made in the calculations.

The results of the analyses are shown in tables 1, 2, and 3, with the calculated ratio of the concentrations in bone and teeth. The average value for the radium content in bone is the highest in the eastern region (1.197 μμg/g ash) and the lowest is in the western region (0.250 μμg/g ash). The samples of the central region with an average value of 0.377 μμg/g ash, show the greatest uniformity of radium content. The average value for the eastern region does not include a horse sample (14C), which has a very low radium content. Results of additional analyses performed in order to check the data obtained previously

are shown in parentheses in tables 1, 2, and 3. The agreement between the results is significantly higher for the bone analyses, with a maximum discrepancy of 16%.

Although final conclusions await the result of further analyses, it appears that the greater discrepancies noted in some teeth can be linked with placental discrimination against radium transfer to the newborn (affecting the radium content of teeth partially formed at birth) and subsequent dietary changes concomitant with tooth eruption and calcification (*3, 4*).

For the moment it is worth noting that, in general, the results of this study show agreement between Ra^{226} content of ashed bones and teeth formed after weaning age. The graphical representation of results in figure 1 shows points scattered around a straight line representing a ratio equal to 1; the average value of the ratios of Ra^{226} in bones and teeth, as given in tables 1, 2, and 3 is 1.03 ± 0.2. It is evident that the ratio, constantly close to 1, is not a function of the radium concentration if the analysis is confined to the second or third premolar tooth, even though the absolute concentration in bone varies by a factor of twenty. The fact that such good agreement exists between the radium content in teeth and bones indicates the potential usefulness of Ra^{226} analyses of teeth for the estimation of body burden; it must be noted, however, that this usefulness is predicated upon knowledge of animal history and proper selection of the tooth specimen.

The results of analyses of other radioelements in such samples will be reported later.

TABLE 1.—RADIUM-226 CONTENT OF BOVINE BONES AND TEETH, WESTERN REGION

Location and age	$\mu\mu$g Ra^{226}/g ash [1]			Ra^{226} ratio (Bone/tooth)
	Bone	Tooth		
		Code [2]	Value	
Spokane, Wash. 4 yrs. 7 mos.	0.380	P3 P2	0.380 (0.341)	1.00
Inland Emp., Wash. 3 yrs.	0.270	P2	0.220	1.23
Elk Grove, Cal. 17 yrs.	0.185	P2	0.221	0.84
Elk Grove, Cal. 17 yrs.	0.191	P3	0.244	0.78
Salt Lake City, Utah 10 yrs.	0.232	P2	0.261	0.89
Anthony, N.Mex. 6 yrs.	0.245	P2	0.286	0.86
Average	0.250			

[1] Average value of two or more analyses; range of estimated error = ±0.006–0.02 $\mu\mu$g/g ash; results of additional analyses in parentheses.

[2] Code:
DP2 = second deciduous premolar
DP3 = third deciduous premolar
I3 = third permanent incisor
14c = 4 mm slice cut at the extremity of the crown
14r = tip of the root (6 mm)
M1 = first molar
P2 = second permanent premolar
P3 = third permanent premolar.

TABLE 2.—RADIUM-226 CONTENT OF BOVINE BONES AND TEETH, CENTRAL REGION

Location and age	$\mu\mu$g Ra^{226}/g ash [1]			Ra^{226} ratio (Bone/tooth)
	Bone	Tooth		
		Code [2]	Value	
Cogswell, N. Dak. 7 yrs.	0.327	P3	0.370	0.88
White Bear, Minn. 5 yrs.	(0.288) (0.247)			
Glyndon, Minn. 3 yrs.	0.331	DP3	0.253	1.30
Zumbro Valley, Minn. 7 yrs.	0.333	P3	0.370	0.90
Omaha, Neb. aged cow	0.414 (0.398)	P3	0.467	0.88
Lyndon, Kans. 6 yrs.	0.389	P2	0.340	1.14
Lyndon, Kans. 5 yrs.	0.431 (0.430)	P3 P2	0.485 (0.621)	0.88
Lyndon, Kans. 5 yrs.	0.483 (0.508)	P2 M1	0.293 (0.226)	1.60
Wellston, Okla. 6 yrs.	0.333	P3 P2	0.329 (0.299)	1.01
Shawnee, Okla. 5 yrs.	0.396 (0.386)	P3 P2	0.449 (0.563)	0.88
Amarillo, Tex. 3 yrs.	0.405	P2	0.426	0.95
Chicago, Ill. 5 yrs.	0.395	P3 Not erupted molar	0.364 (0.235)	1.08
Average	0.377			

[1] Average value of two or more analyses; range of estimated error = ±0.006–0.02 $\mu\mu$g/g ash; results of additional analyses in parentheses.

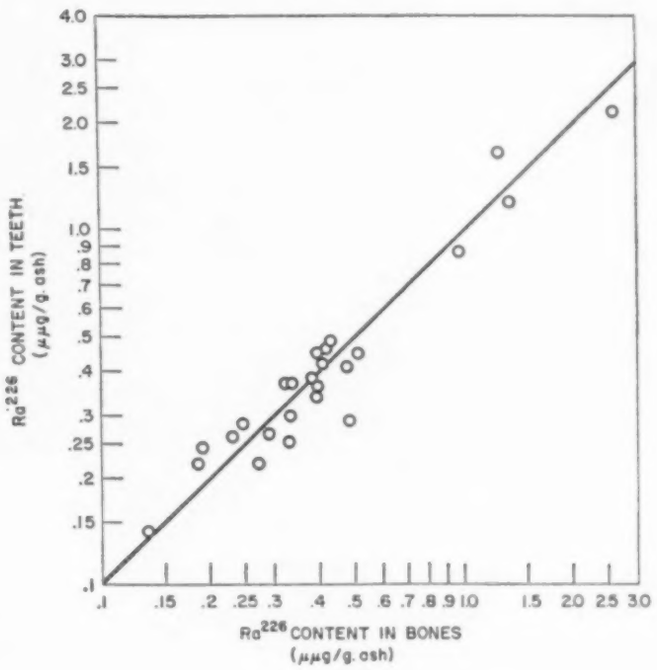
[2] Code:
DP2 = second deciduous premolar
DP3 = third deciduous premolar
I3 = third permanent incisor
14c = 4 mm slice cut at the extremity of the crown
14r = tip of the root (6 mm)
M1 = first molar
P2 = second permanent premolar
P3 = third permanent premolar.

TABLE 3.—RADIUM-226 CONTENT OF BOVINE BONES AND TEETH, EASTERN REGION

Location and age	$\mu\mu$g Ra^{226}/g ash [1]			Ra^{226} ratio (Bone/tooth)
	Bone	Tooth		
		Code [2]	Value	
Columbus, Ohio 2 yrs.	0.511	DP3 DP2	0.448 (0.429)	1.14
Wapakoneta, Ohio 2 yrs. 6 mos.	0.526	DP2 DP3	0.415 (0.488)	1.26
Augusta, Ga. 8 yrs.	0.973	I3	0.865	1.12
Augusta, Ga.[3] 5 yrs.	2.58	I3 M1 14c 14r	2.16 (0.800) (2.35) (3.53)	1.19
Fayetteville, N.C. 2 yrs.	1.345	DP2	1.20	1.11
Fayetteville, N.C. 1 yr.	1.25	M1	1.08	0.74
Charleston, S.C.[4] 9 yrs.	0.136		0.141	0.96
Average	1.197			

[1] Average value of two or more analyses; range of estimated error = ±0.006–0.02 $\mu\mu$g/g ash: results of additional analyses in parentheses.
[2] Code:
DP2 = second deciduous premolar
DP3 = third deciduous premolar
I3 = third permanent incisor
14c = 4 mm slice cut at the extremity of the crown
14r = tip of the root (6 mm)
M1 = first molar
P2 = second permanent premolar
P3 = third permanent premolar.
[3] The unusually high content in this sample has been verified and confirmed by gamma-spectrum scintillation counting.
[4] Horse sample.

FIGURE 1.—Ra^{226} CONTENT OF BOVINE BONES AND TEETH



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